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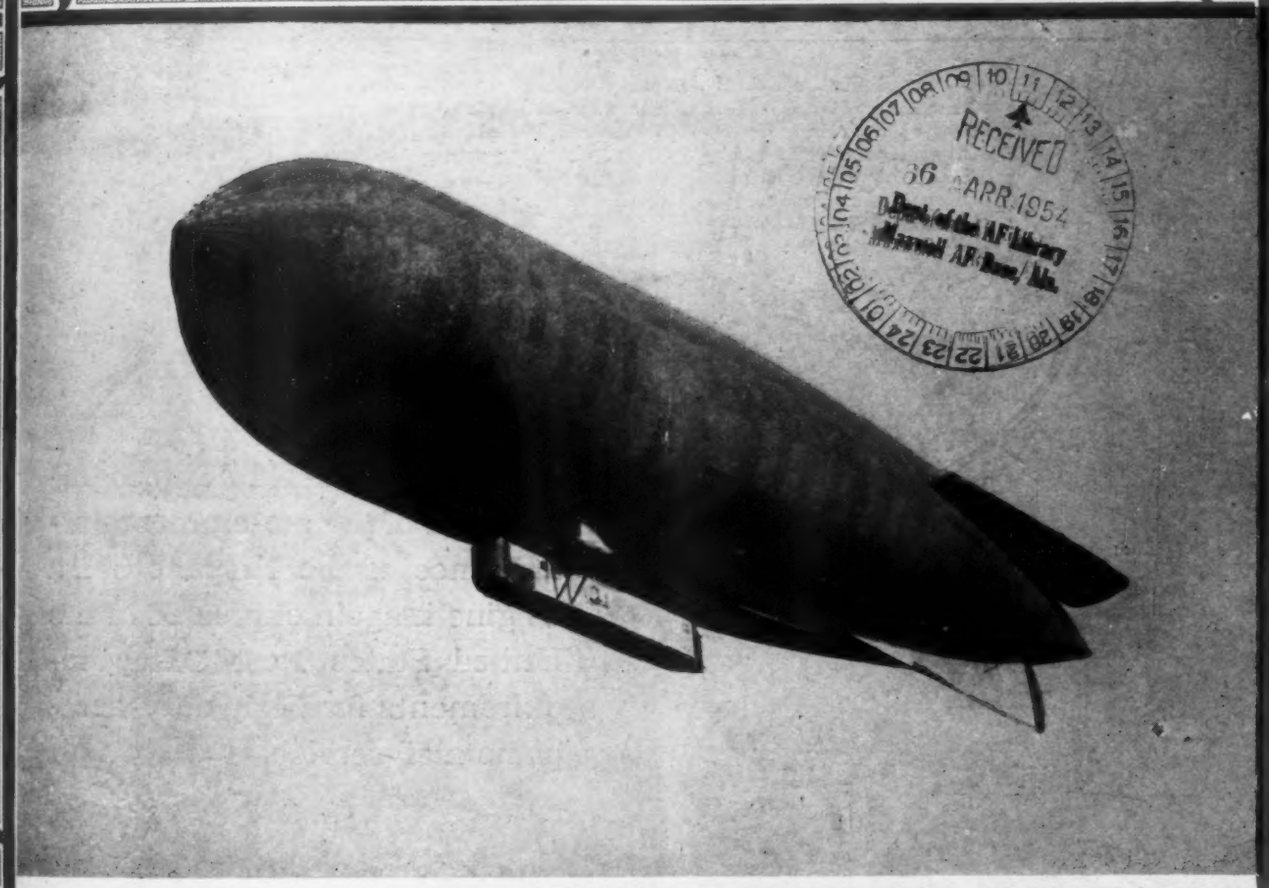

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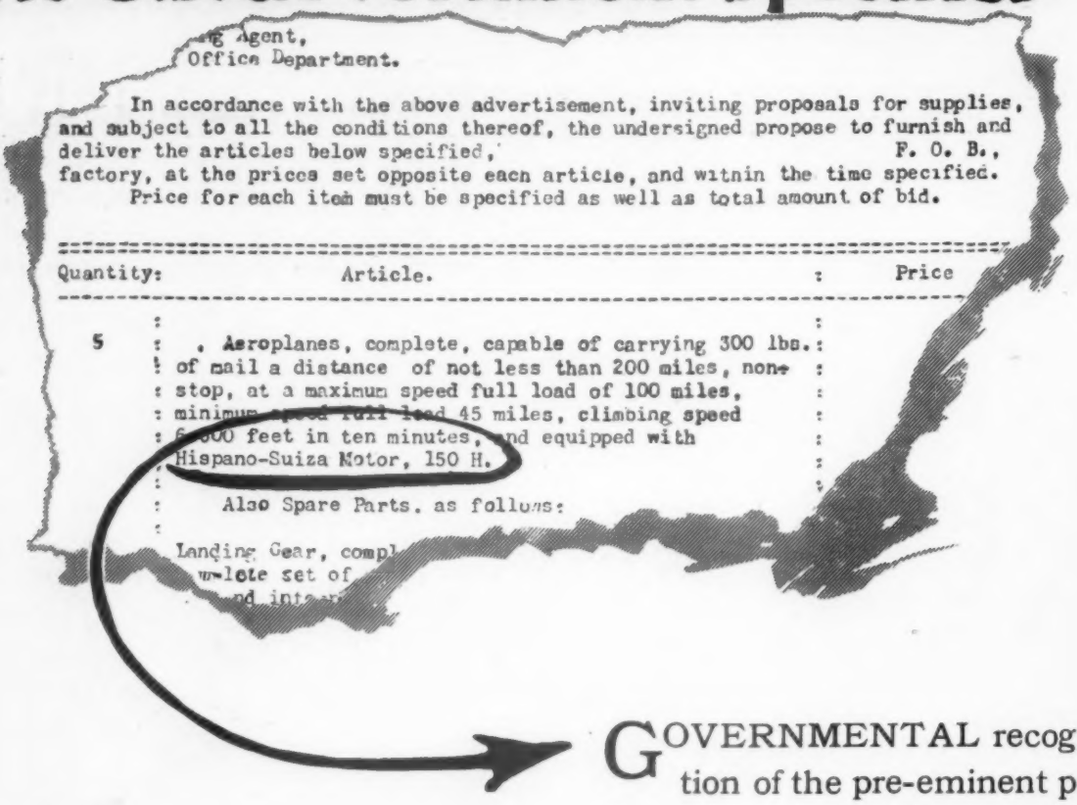

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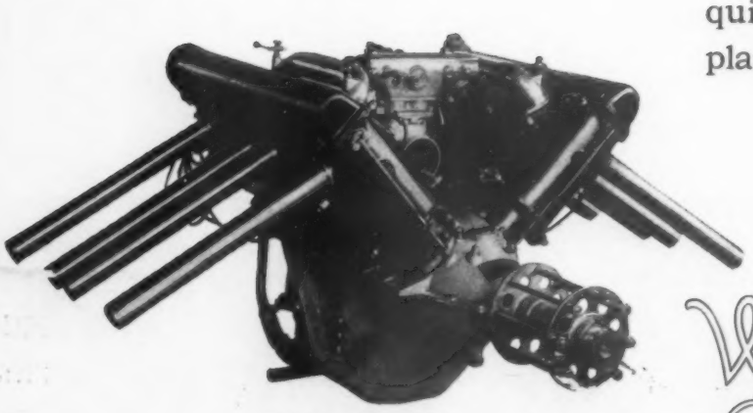

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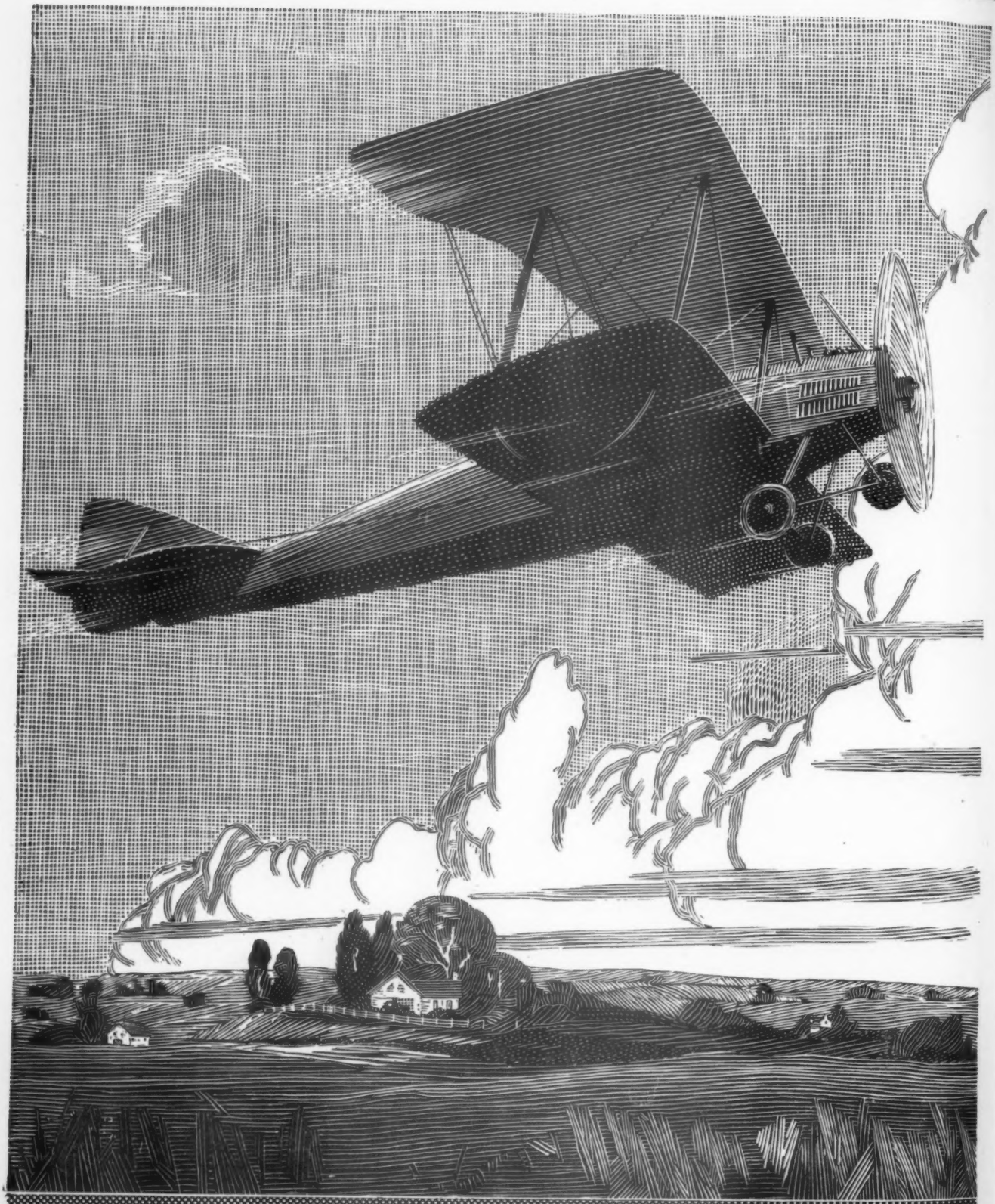
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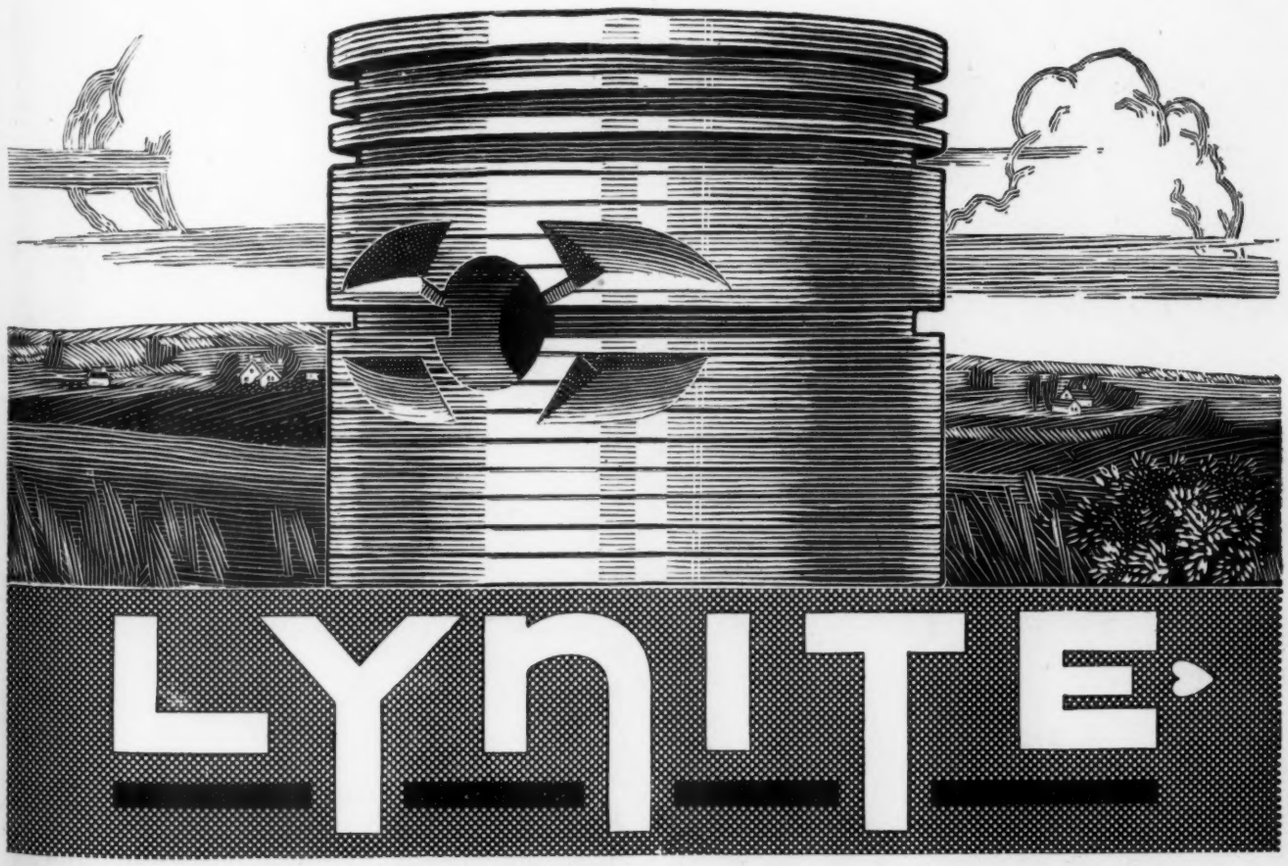

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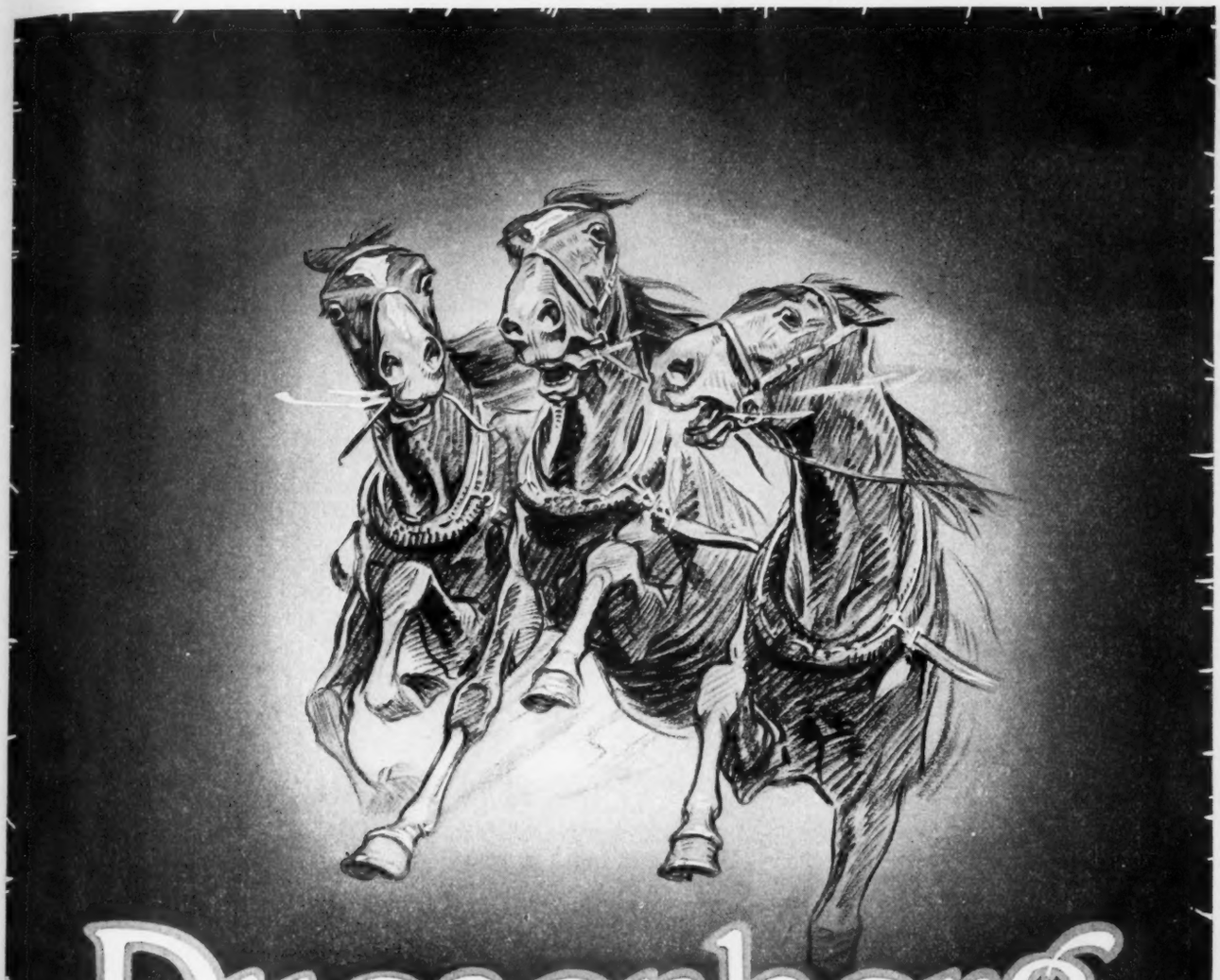

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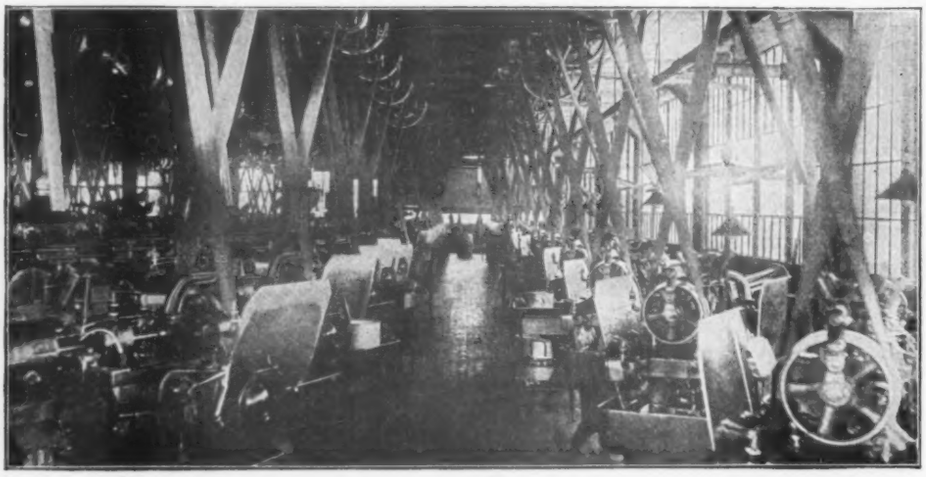

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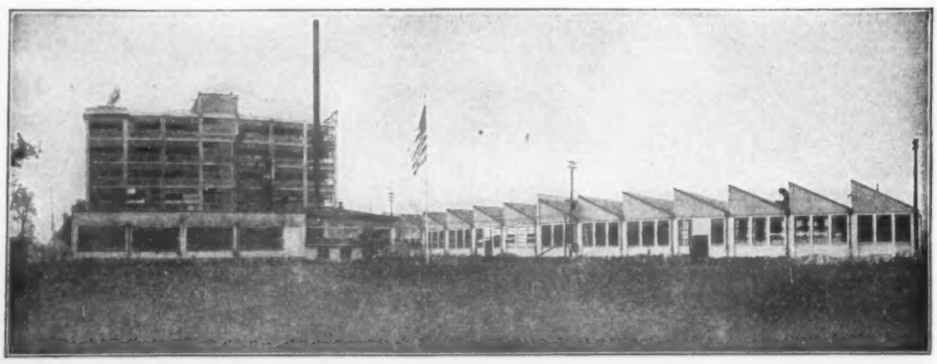

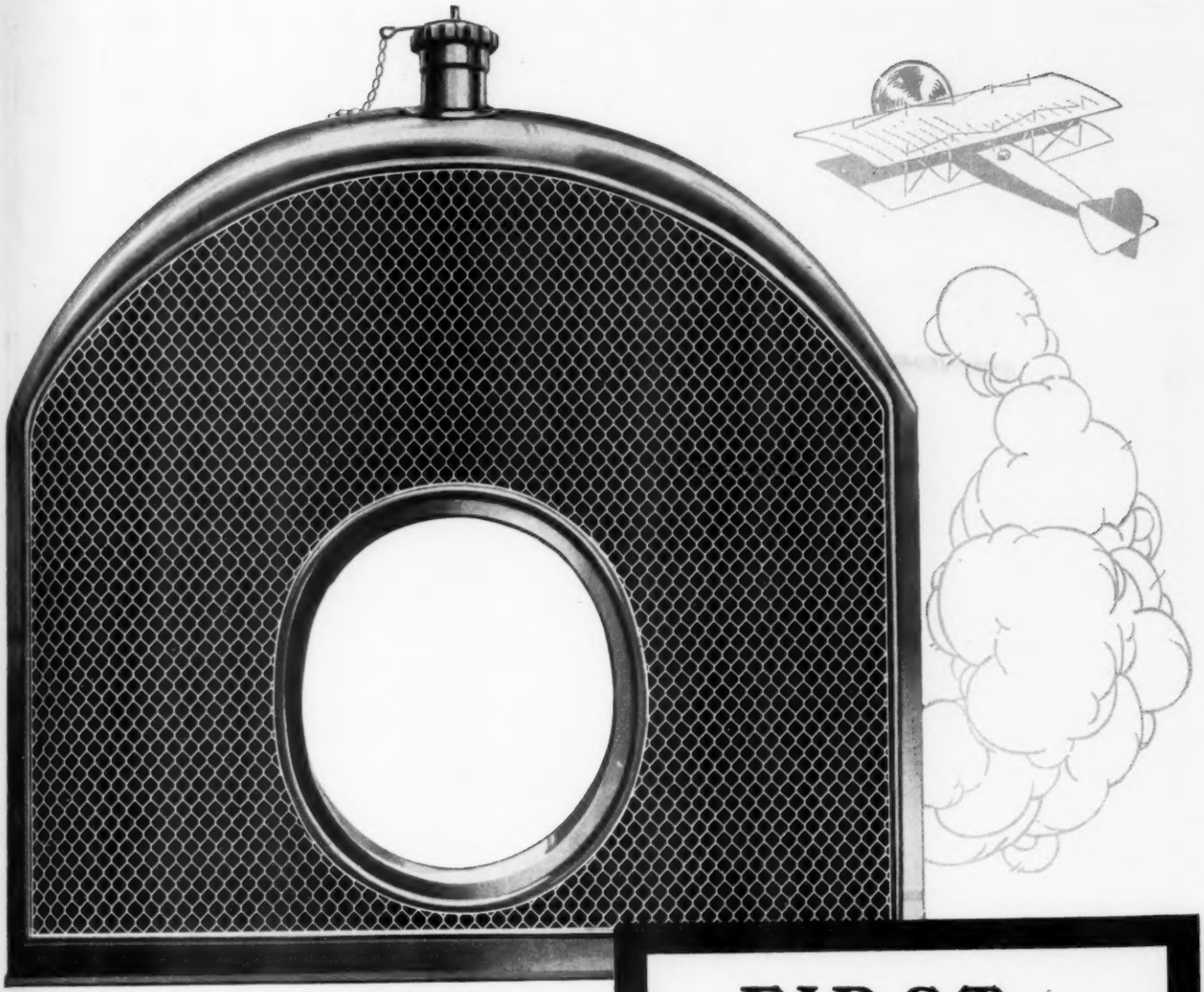

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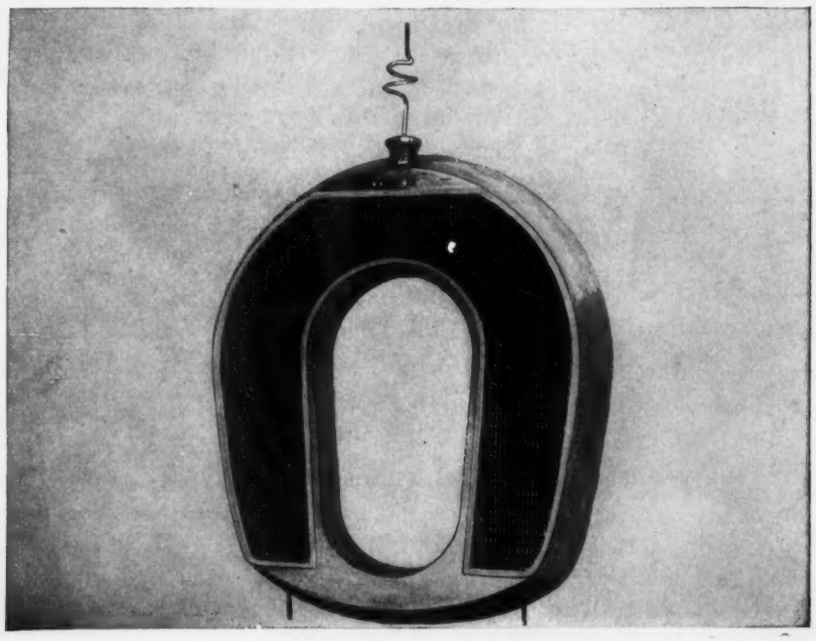

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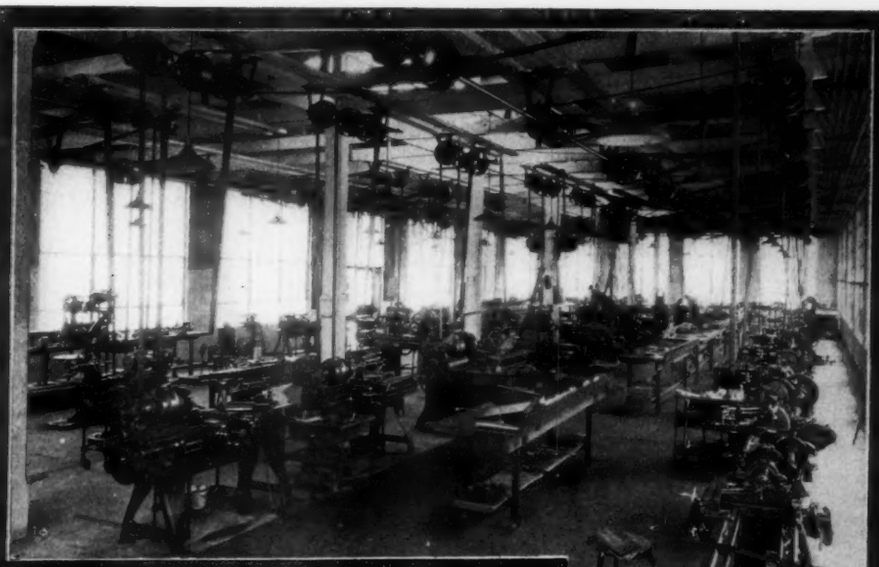

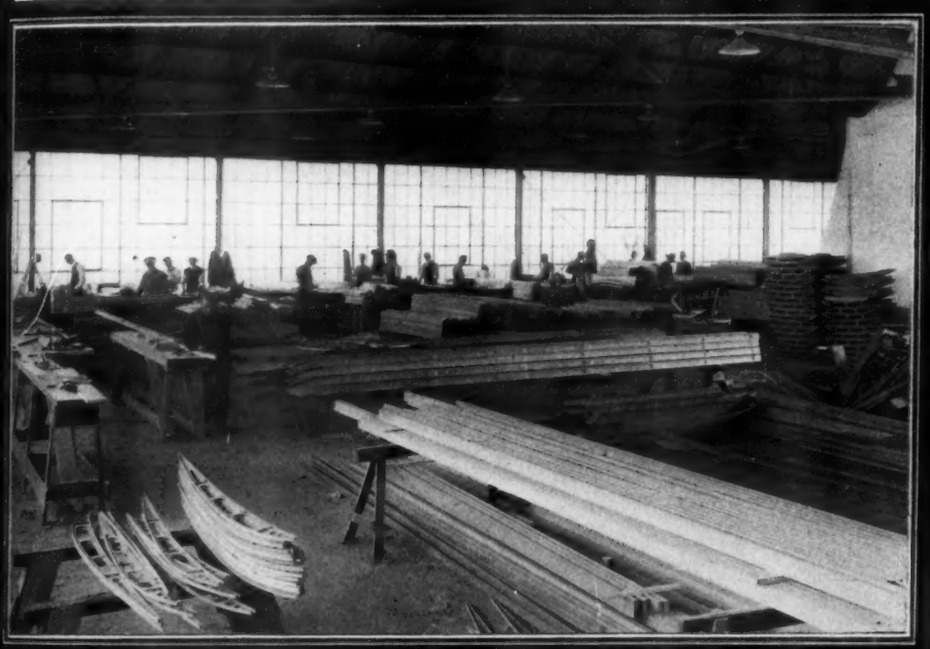

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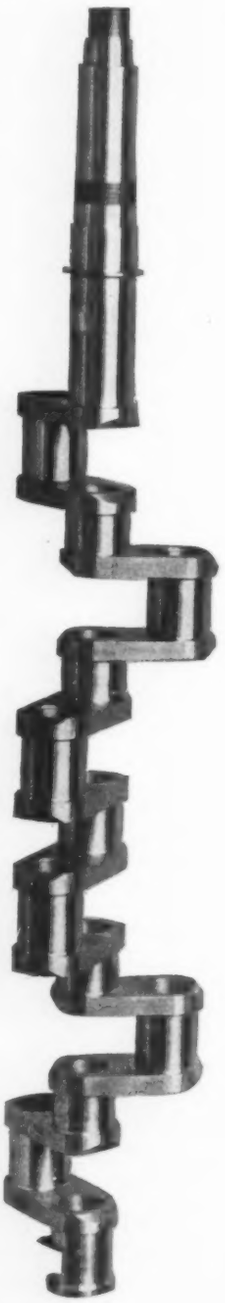

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VOL. IV. NO. 2

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Vol. IV | February 15, 1918 | No. 2

Approximating the Static Thrust and Brake Horse Power of Air Propellers

By W. Bernard Murphy, M.Ae.S.

In the July 15, 1917, issue of AVIATION AND AERONAUTICAL ENGINEERING there appeared an article by F. W. Caldwell entitled "Method of Approximating Static Thrust of Propellers," which I desire to make the subject of the present article.

Mr. Caldwell's data are somewhat meagre and may lead to results 20 per cent from the actual figures, since he ignores the variable element of blade widths, a most important factor. Therefore a more suitable method is obviously desirable.

In this connection I wish to call attention to the Laws of Airscrews discovered by W. R. Turnbull, A.F.A.E.S. From these laws the static thrust and the brake horse power (on the ground) of any propeller can easily be determined within 5 per cent of the actual values. These laws were first published in the AERONAUTICAL JOURNAL of October, 1910, and were confirmed later by Riabouchinsky, Eiffel and others. They must not be confused with "Two Fundamental Laws of Aerodynamics" also discovered by Turnbull and published in the same journal in January, 1912.

Briefly stated, Turnbull's laws of airscrews are represented by the two formulae:

$$T = UR^2 D^4$$

and

$$P = QR^3 D^5$$

*in which T = static thrust in lbs.

P = b.hp. (Absorbed by propeller revolving with no forward motion.)

R = revolutions per minute.

D = diameter of the screw in feet.

p = pitch of the screw in feet.

The coefficients U and Q are variable, depending on the units employed and the relation of the pitch (p) to the diameter (D).

By using Turnbull's curves and substituting for the known quantities it is possible to determine quite accurately both the static thrust and the horsepower absorbed. I reproduce the curves herewith so as to show how they may be applied to concrete cases. It is assumed that the brake horsepower and the maximum revolutions per minute obtained in the air are known. Also, that the diameter, maximum blade-width and the value of the $\frac{\text{pitch}}{\text{diameter}}$ of the airscrew have been chosen. As the revolutions on the ground are always less than those obtained in the air by about 12 per cent, the necessary deduction must be made to obtain accurate results.

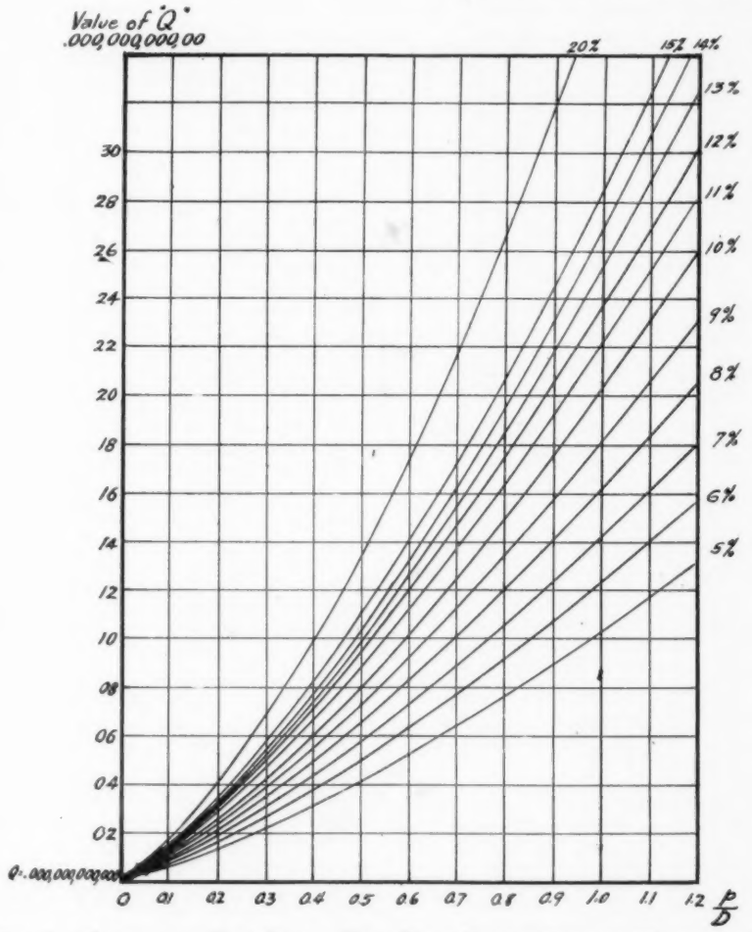


FIG. 1. CURVES FOR TWO-BLADE, FLAT-FACE SECTOR SCREWS (TURNBULL).
B.HP. $= Q \times R^3 \times D^5$

To take an actual example, let us assume that the engine to be used gives 100 b.hp. at 1250 r.p.m. in the air. A maximum velocity of 100 m.p.h. is to be attained and the diameter of the airscrew to be 9 ft. With the use of the curves, Figs. 1 and 2, and the above mentioned formulae, the static thrust, and maximum blade width are first determined in the following manner:

Maximum revolutions less 12 per cent = 1100 r.p.m. on ground. From b.hp. curves supplied by the engine makers the brake horsepower delivered at 1100 r.p.m. is obtained, we will assume it to be 93 b.hp. Substituting for the formula:

$$P = Q \times 1100^3 \times 9^5$$

we obtain, $93 = Q \times 1100^3 \times 9^5$

from which $Q = 0.000,000,000,001,184.$

We must now determine the ratio of p/D from the air speed of the machine assumed in this case to be $V = 100$ m.p.h. We can obtain this from the formula for pitch,

$$p = \frac{88V}{R}$$

or in the case assumed

*These laws can be used with any units of time, weight, power, etc., not necessarily the English Units.

$$p = \frac{88 \times 100}{1250} = 7.05 \text{ ft.}^* \quad \therefore \quad \frac{p}{D} = \frac{7.05}{9} = 0.783$$

We now have the ratio p/D and a value for Q and if we enter the curves Fig. 1 we find the maximum width (W. Max.)

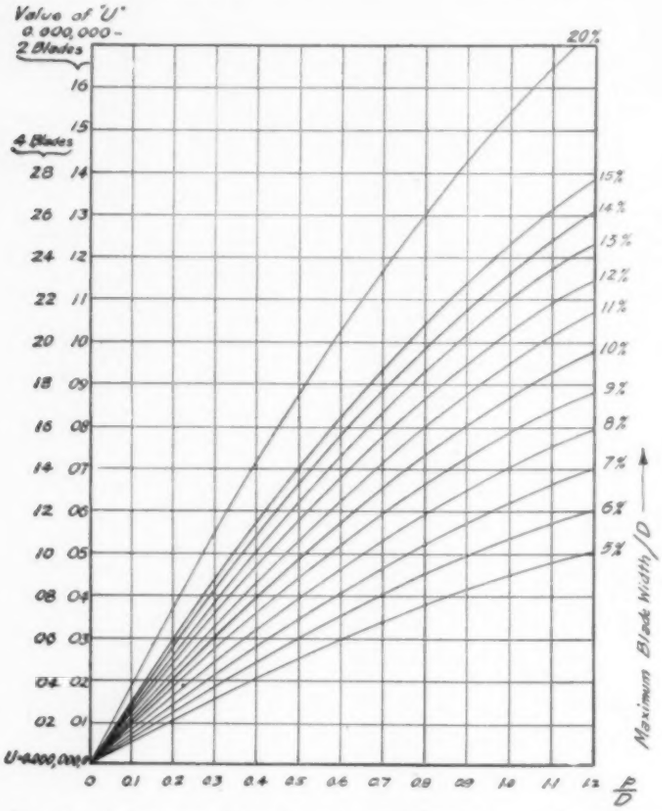


FIG. 2. CURVES FOR TWO-BLADE AND FOUR-BLADE, FLAT-FACE SECTOR SCREWS (TURNBULL)

$T = UR^2D^4$. T = STATIC THRUST IN LBS. R = REVOLUTIONS PER MINUTE. D = DIAMETER IN FEET

of a sector-screw to be 8.1 per cent of the diameter, or 8.1 per cent of 9 ft. = .728 ft. = 8.75 in.

Having now determined our W. Max. for the conditions assumed we can now turn to the curves on Fig. 2 and with this

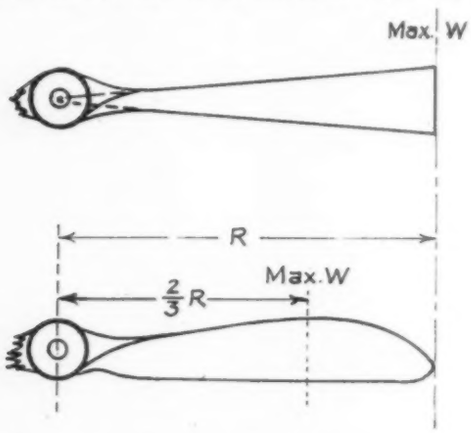


FIG. 3. SECTOR AIRSCREW (ABOVE) AND MODERN OR STANDARD AIRSCREW (BELOW). MAX. W = MAXIMUM BLADE WIDTH. R = RADIUS

value and the value of p/D already found, find the corresponding value of U to be 0.000,000,059,5.

We may now by direct substitution in Formula 1, obtain the static thrust as follows:

$$\begin{aligned} T \text{ in lbs.} &= U \times R^2 \times D^4 \\ &= .000,000,059,5 \times 1100^2 \times 9^4 \\ &= 472 \text{ lbs.} \end{aligned}$$

This gives a close approximation for two-bladed airscrews of sector shape having a flat face, but if it is desired to obtain a similar result for the more modern shaped screws, say, having a curved leading edge and a straight trailing edge, with the maximum blade width at about ⅔ radius of the screw it is necessary to introduce some modifications as found by Turnbull from large sized screws of this type.

For approximate results all that is necessary is to multiply the value of the maximum width (sector screw values) by 1.135. In Fig. 3 is shown the difference between sector screws and standard screws. It will be noticed that the maximum width of the former is at the blade tips while of the latter is at ⅔ of the radius.

Insufficient attention has been paid to the fact that where a large horsepower has to be absorbed by an airscrew of restricted diameter the sector screw is the more useful. But where the diameter is not restricted the standard screw is more efficient owing to the diminution of the blade-tip losses.

I have to thank Mr. Turnbull, the discoverer of these laws, for his kind permission to republish them. Unfortunately many of the more modern designers having at hand the latest aerofoil data and the results of numerous actual experiments, evolve their propellers by empirical formulae which in some cases show little knowledge of the actual aerodynamics concerned. It is to be regretted that the originator of these and the other laws mentioned does not republish his old works with the addition of his more modern data in a suitable volume, which would be of immense value to the many aeronautic engineers at present trying to obtain knowledge.

Book Review

D'OREY'S AIRSHIP MANUAL. By Ladislas d'Orey, M.S.A.E. The Century Co. ($4. 240 pp., over 150 ill.)

The airship—or dirigible balloon—may truly be called the least understood and most misjudged type of aircraft in existence today. Its very name conjures up visions of Zeppelins brought down in flames, of huge, unwieldy and expensive "gas bags" which become the easy prey of the elements, if not of the swift airplane. This impression is further enhanced by the fact that this country has yet to produce an airship comparable to the large and powerful craft developed by France, Italy, and Germany, for American specimens of the airship have almost exclusively consisted of small, virtually unmanageable exhibition machines of the most primitive design.

It follows that, for want of reliable information and practical demonstration the American public sees only the negative side of the problem; the positive side, that is, the actual achievements of the modern airship, is as a rule entirely lost sight of.

D'Orey's Airship Manual, a profusely illustrated volume of handy size, furnishes probably a larger and more varied amount of information on this subject than has hitherto been available to the English speaking public. It is not, strictly speaking, a text book on airship construction and operation; the rather sketchy and, often, almost epigrammatical style in which the mechanics of the airship are treated would fail to satisfy this purpose, if such was the author's intention. But there is hardly a feature in modern airship practice that is not touched upon sufficiently to give the reader, and particularly the one unfamiliar with this subject, a clear and comprehensive view of the present status of the problem. A separate chapter is devoted to a comprehensive survey of the work of airships in the Great War.

The statistical part of the book, which is by far the larger of the two, gives in a readable, tabulated form detailed data on every airship built up to the Great War and such as have since been released by the censor. In this connection the data and diagrams of the United States naval scout airships authorized in 1917 should prove of interest to American readers.

The statistical part also includes a large amount of data on the military airship fleet, the Allied and German airship losses during the war, the German airship raids on England, the 150 or so airship sheds scattered about Europe, and the experimental passenger airship line which Germany organized in 1910 and maintained up to the outbreak of the war.

* This is the effective pitch and for a strict consideration of the case the pitch due to the angle of attack must be added, but this is not necessary for approximate results.

The Wind Channel: Its Design and Use*

By J. R. Pannel, A.F.Ae.S.

It has long been realized that experiments in the laboratory on small models afford in certain cases a means of obtaining, cheaply and rapidly, information on the behavior of the actual structure under the conditions in which it is to be used. This plan has been adopted in many branches of science, and in none to a larger extent than in naval architecture and aeronautics. The problems to be investigated are usually those connected with the motion of bodies through a fluid, but if we accept the principle of relative motion we have an alternative method open to us for our model experiments. We may, if we wish, reverse the conditions and set the fluid in motion, the model remaining stationary. Generally speaking, one plan has been adopted in naval architecture and the other in aeronautics. In the former case models are towed through water in a ship tank, while in the latter they are placed in a tube through which air is passed. One difficulty in the case of the moving fluid is to estimate the velocity, and mainly for this reason, a certain amount of experimental work has been carried out in air by moving the body on a whirling arm. This plan was invaluable in providing a standard anemometer calibration, but this done, there is only an extremely small amount of work which cannot be carried out more satisfactorily in the wind channel. The stationary model offers many advantages, particularly in connection with measurements of the forces acting upon it, and the writer is of the opinion that the method might be applied with advantage in experiments on ship models to a greater extent than has hitherto been the case.

The application of model results to the actual structure is often a matter of considerable difficulty, but as the amount of information obtained in aeronautics increases it appears probable that the change of the coefficients in passing from model to full scale, which is small in the majority of cases, will soon be known with considerable accuracy. In these circumstances the value of model experiments becomes very high, and it appears that the performance of an airplane can be predicted by this means with considerable accuracy.

It must be clearly understood, however, that the value of model experiments is entirely dependent on their accuracy. Changes in parts of an airplane may often cause appreciable differences in the performance, though the parts themselves may be so small as to be difficult of reproduction at all on a 1/12th scale model. An instance of this may be cited. It has been stated that in a certain type of airplane the substitution of streamline for circular wires caused an increase of ten miles per hour in the speed, yet it is quite certain that only the highest experimental accuracy would enable the difference to be measured on a 1/12th scale model.

Again, some experiments were carried on a 1/25th scale model of a large biplane in order to determine, among other things, the angle at which the tail plane of the machine should be set and the position of the rudder hinge, in order that the rudder should be just stable. The model experiments determined the required angle of the tail plane, and showed that the rudder would be neutral if the hinge were moved forward a few thousandths of an inch. The determination of the latter quantity represented the extreme limit of accuracy, but it was found in the actual machine that the rudder was rendered stable by a forward movement of the hinge of an inch or so. Moreover, this machine was one of the earliest of its kind, and it was feared that an error in the setting of the tail plane (which was based on the results of the model experiment) might give rise to forces on the machine greater than those which could be exerted by the controls. The machine, however, carried out its trials without accident, and its prototype is today one of the most successful British bombers. If it be conceded that the model experiments prevented accidents to only one machine, the saving in mere money was sufficient to carry on the work of the entire aeronautical department of the National Physical Laboratory for many months.

The present paper deals with some of the methods and apparatus which have been employed in carrying out experiments in a wind channel.

* Paper read before the Aeronautical Society of Great Britain.

Types of Wind Channels

When the author was invited to prepare a paper on "The Wind Channel" he was at once impressed by the fact that such a general title could only be justified if a description of all the channels in which satisfactory experiments had been carried out was included. An attempt has, therefore, been made to describe briefly the more important channels of the world, as far as they are known to the writer, the greatest attention being paid to those in which results of obvious value have been obtained. The author's actual experience is, however, limited to the channels at the National Physical Laboratory, and the paper must be regarded as mainly a description of that type. It is difficult to avoid bias in favor of apparatus with which one is familiar, but the writer believes that this type of low resistance channel in which the air is drawn from a large reservoir, is unequaled for accuracy and rapidity of operation. This view was supported by Lieut. J. C. Hunsaker, of the United States Navy, who, after a tour of the principal aerodynamical laboratories of the world, recommended the erection at the Massachusetts Institute of Technology at Boston, U. S. A.† of a four-foot channel which in all the essential details is an exact copy of those at the N. P. L.

It may be remarked that considerable progress has been made since the apparatus and methods described in this paper were in use, but the exigencies of the present situation forbid the publication of any further details.

It will be convenient to group the channels under the countries to which they belong, and we may commence with the one which perhaps did more than any other in the early days of aviation towards the development of practical types of airships and airplanes.

France

A small wind channel was erected at the military establishment at Chalais-Meudon, which was in charge of Colonel Renard, as long ago as 1877, and constitutes the earliest channel known to the writer. It was 13 ft, long and had a diameter of 2½ ft. A considerable amount of work appears to have been carried out on models of airships, but the results were regarded as confidential and were not published.

A very extensive laboratory was founded in 1911 by M. Deutsch de la Meurthe at St. Cyr. It includes laboratories, workshops, administration building, several wind channels, and an open-air track upon which runs an electrically driven carriage. Experiments are made on this carriage with full-size airplane wings, and it is by this work that the St. Cyr Laboratory is most generally known.

No details of the channels are available, but the form is understood to be circular with the balance situated underneath the channel.

A very large amount of experimental work has been carried out in the laboratory of Eiffel, situated in the Champ de Mars, Paris. The laboratory was constructed about 1910, and contained a circular channel nearly 5 ft. in diameter, in which experiments were made in continuation of those with falling plates on the Eiffel Tower. The characteristic feature of the channel is that the experiments are made in an hermetically sealed room, in which the pressure is equal to the static pressure in the channel. The air stream crosses this room without any solid boundary, and it is stated that larger models can be used than is the case if the stream is confined within rigid boundaries, no sensible eddies being set up. The length of the chamber is 12 ft., and a conical receiver projects slightly into it on the outlet side.

A balance is provided for measurement of lift, drag, and moment, the observers sitting on a platform above the free stream.

A 65 hp. motor was used, and a speed of 65 ft. per sec. attained. Several anemometers of the pressure head type were employed, and compared with the drop of pressure in the closed chamber. The velocity calculated from this pressure difference by the formula

$$V^2 = 2gh$$

was 1½ per cent higher than that given by the Pitot tube. A

† Described in the Smithsonian Misel. Co., Vol. 62.

new laboratory was opened in 1912 at Auteuil. The channel is constructed on exactly the same principle as the earlier one, but the diameter has been increased to 6½ ft. The air is led into the test chamber by a reducing cone whose diameter changes from 13 ft. to 6½ ft. in a length of 11 ft. The stream leaves the test chamber by a bell-mouthed opening and passes to the "discharger," which is a cone increasing from a diameter of 6½ ft. to 11 ft. (which is the diameter of the fan) in a length of 30 ft. This design is stated to be very efficient, as the air reaches the fan at a low velocity and at a pressure little above that of the hall into which it is delivered. A 50 hp. motor is provided, and a maximum speed of 100 ft. per second is attained.

Experiments have been carried out in these channels covering a very wide range of subjects, including the determination of forces and moments on aerofoils, complete models, and bodies, pressure plotting experiments, and tests on series of airscrews.

The convenience of an arrangement which enables the observers to be placed in the sealed test chamber is no doubt great, but it is open to question whether the accuracy of results obtained in this free current is so high as those obtained by the more generally accepted methods.

It has been shown that an error of 0.2 deg. in the assumed wind direction would cause an error of 6 per cent in the value of the drag of an airplane model.

Italy

The principal aerodynamic laboratory in Italy is that of the Brigata Specialisti. It is situated near Rome, and is under the charge of Major Crocco. The apparatus includes a wind channel in which very elaborate precautions were taken to secure uniformity of the flow. The air was forced by the fan into a closed chamber, where the velocity was reduced and the pulsations partly damped out. It then passed to another chamber larger than the first, from which it entered the experimental channel, which was 2.5 ft. sq. Several layers of gauze were introduced, and the flow was stated to be satisfactorily uniform to within a short distance of the wall. The model was supported on the balance just outside the end of this channel, so that at the section of the stream at which the experiments were made there was no solid boundary.

Several balances were in use, that provided for the most accurate measurements being supported on the surface of a vessel of water. The principal part of the wind force was balanced by weights attached to a cord passing over a pulley. Records of the movement of the balance were obtained by means of additional apparatus, in which electric sparks were passed through specially prepared paper.

In 1912 the laboratory was reorganized under the title Lo Stabilimento di Esperienze e Costruzioni Aeronautiche del Genio, and a new wind channel of an entirely different type was erected. This channel is 6½ ft. sq. and 22 ft. long, the air current being produced by a Sirocco (centrifugal) fan, belt-driven from a 30-hp. electro motor. The balance is placed in a sealed test chamber, there being a gap of about 3¼ ft. at the position at which the experiments are made. The method of test is thus similar to that of Eiffel, except that the length of the "free" stream in which the measurements are made is much less. The test-room is divided into two parts, the upper of which contains the balance and its observer, while in the lower is placed the manometer and various other instruments. The speed of the air current can be regulated from this chamber by opening or closing shutters on the intake side of the fan.

Two anemometers are used, one situated upstream of the test section and another placed near the outlet of the channel. The uniformity of the flow is improved by the introduction, near the fan, of a layer of gauze and a honeycomb, and it is stated that over a period of one or two minutes (the time required for an observation) the flow can be kept sufficiently steady. The range of velocity available is from about 7 ft. per sec. to 52 ft. per sec. Experimental work of considerable value had been carried out in this laboratory till the year 1914, but information as to the results obtained since that data is not at present available.

Germany

The principal aerodynamic laboratory in Germany was that at Göttingen, of which Prandtl was in charge. This channel is of the enclosed type, in which the air circulates continuously round an approximately rectangular path. The test section of the channel is 6½ ft. sq., but if high speeds are required an octagonal liner can be fitted, reducing the diameter to about 3.3 ft. Guide blades are provided at the corners and a honeycomb and gauze screens are introduced to secure uniformity in the flow. To this end also the walls of the honeycomb are made double, so that any cell can be partly closed by bending one of the walls across it. The gauze is also rendered finer where necessary by painting. The arrangements for the measurement of forces are unique, separate balances being provided for lift and drag, a total of four being required for the complete investigation of forces and moments. The model is suspended on wires and is restrained in a horizontal plane by two wires at an angle of 120 deg. to each other. One of these wires is fastened to the wall of the channel, while the other passes through it and is attached to the drag balance. The drag is calculated from the increase in tension of this wire when the air current is started.

Four supporting wires are brought to a light rod, placed along the wind direction, from which the model is suspended, but it appears to the writer preferable to attach the wires to the model directly, as in the case of a low resistance form the flow has been found to be very sensitive to small obstructions. This modification may perhaps have been subsequently introduced. Each pair of wires is taken to a balance above the channel for measurement of lift, and the fourth balance is used in obtaining rolling moments.

The velocity is measured by a kind of Pitot tube with an inclined tube alcohol manometer, and an automatic regulator is provided to maintain a constant speed. This regulator consists of two bell jars, hung, with their lower ends under water, from a balanced arm. One jar is connected to the channel immediately in front of and the other immediately behind the airscrew, a pressure difference proportional to the square of the wind speed being thus obtained. The speed is set to the desired value by the regulating resistances and a weight on the regulator balance set to a position marked upon it for the required speed. A change of speed now causes the balance arm to move over to one stop operating a resistance in the field circuit of the motor. The stops are also mounted on a swinging arm whose motion is damped by a vane moving in a fluid. This latter device reduced "hunting" due to over-regulation.

An electro motor drives the fan, a maximum speed of 33 ft. per sec. being attained in the 6½ ft. channel and 55 ft. per sec. when the section is reduced to 3.3 ft.

For several years before the war the work carried out in this channel dealt mainly with the resistance of stream-line bodies, including measurements of pressure distribution. Experiments have also been made on the resistance of spheres, and to a limited extent on aeroplane models, though the latter branch of study has doubtless been extended recently.

America

A wind channel was erected in an aerodynamical laboratory at Washington in 1901 by Mattulath. The section was 6 ft. sq. and the length 40 ft. The current was produced by a fan 5 ft. in diameter, driven by a 12-hp. electro motor, a maximum speed of 40 ft. per sec. being attained.

It was provided with a balance for measurement of lift and drag, and with a torsion balance.

This channel was used by Zahm in 1904 for his experiments on the skin friction of flat boards. The method adopted was to suspend the boards by wires from the roof of the laboratory and observe their displacement under the wind forces.

No complete description of this channel has been available, but it appears to be of a satisfactory type. As far as the writer is aware, however, no important work has been carried out since that of Zahm.

A channel of the N. P. L. pattern has recently been erected in the Massachusetts Institute of Technology.

A large channel is installed at the Washington Navy Yard. It is of the closed circuit type, the dimensions of the working section being 8 ft. sq. and 33 ft. long. It is fitted with a honeycomb at the entrance to the working section, some of the cells being closed to improve the uniformity of the flow, which is said to be within 2 per cent of the mean. The balance and motor control board are situated above the channel, the balance being similar to that used by Eiffel.

The current is produced by a 500-hp. electro motor, driving a centrifugal fan; a maximum speed of 75 m.p.h. can be attained, but considerable heating of the air takes place at this

speed, and tests are usually carried out at 40 m.p.h. The velocity is measured by pressure tube anemometers which have been calibrated against the N. P. L. standard.

Russia

The principal experiments in aerodynamics which have been made in Russia are those conducted at the Institute at Koutchino, near Moscow,* under the superintendence of Riabouchinsky. The equipment includes a straight channel of circular section 4 ft. in diameter and about 48 ft. long. The air is drawn through the channel by a fan, which is belt-driven from an electro motor, and is returned through the building in which the channel is placed. A maximum speed of about 20 ft. per sec. is attained, and a balance, whose axis is horizontal, is provided for force measurements.

Experiments in this channel have, on the whole, been of scientific, rather than of an engineering, character, and include observations on the resistance of spheres, autorotation of plates, resistance of square plates, etc. The reports issued include several relating to propellers.

Great Britain

The principal aeronautical laboratory for model experiments in this country is at the National Physical Laboratory, and comprises five wind channels, enclosed whirling arm, small water channel, and two wind towers. A 4 ft. air channel is in use at the Royal Aircraft Factory in connection with the full-scale experimental work, which differs from those at the N. P. L., in that no distributor is used. The channel is located in a large airship shed, and no disturbance is caused at the intake due to the eddies from the airscrew. The same modification is applied in the channel at the Royal Naval Air Station at Kingsnorth, which has a section 6 ft. (horizontal) by 4 ft. In this case a four-bladed airscrew driven by a petrol motor is placed in the open air and the current is drawn through the channel from an airship shed. A speed of 100 miles per hour is attained.

A small wind channel was installed at the East London College in 1911, and is still in use for certain experiments. This has been replaced by a 4-ft. channel, which is a copy of the National Physical Laboratory channels, except that it is constructed of iron. The writer is indebted to Norman Piercy, who is in charge of the channel, for the following particulars. The balance differs from those at the N. P. L., the axis being horizontal, and includes one notably novel feature. Considerable trouble had been experienced with the pivot upon which the balance of the earlier channel was supported, and at the suggestion of Prof. Macgregor Morris this pivot was discarded in favor of a metal diaphragm whose plane is vertical, and to which the balance is rigidly attached. The diaphragm is bolted between two stout metal rings, the motion of the balance being resisted by the flexual rigidity of the diaphragm.

With the diaphragm at present in use, the limit of sensitivity is about 1/6000th of a pound. Greater sensitivity could be obtained by the use of a thinner diaphragm, but one objection to the method appears to be that the sensitivity cannot be readily changed in passing from one test to another.

The angle of incidence is varied by rotating the balance in a bearing the outer part of which constitutes the attachment to the diaphragm. The lift forces are measured by weights hung on the beam of the balance; the drag forces are transmitted by a horizontal bell crank to another bell crank whose plane is vertical, and upon the horizontal limb of which the measuring weights are hung.

The maximum velocity which can be attained at present is 50 ft. per sec., but sufficient power is provided to attain 90 ft. per sec. when the driving arrangements have been modified.

There are many other channels in use in this country, but the author believes that the more important of them are copied from those at the N. P. L.

The Channels of the National Physical Laboratory

The first N. P. L. air channel was constructed in 1902. It was designed by Dr. T. E. Stanton, F. R. S., and used by him for the experiments on the air resistance of plane surfaces. This channel consisted of a vertical tube 2 ft. in diameter, through which the air could be drawn downward by a fan placed at its lower extremity. The air was delivered into the large engineering shop so that practically still air was continuously supplied at the intake of the channel. It is, therefore, not surprising that the steadiness of the flow was comparable with that of the newer channels. A balance was provided for measurement of forces along the wind only.

For measurement of velocity Dr. Stanton devised a pitot and static head, of which the present laboratory standard is the outcome; the only essential difference is that, for convenience, the tubes are now concentric, instead of some two inches apart, as in the original form. Much useful work was carried out in this channel, and it is still in service at the present time.

The Advisory Committee for Aeronautics was formed in 1909, and an extensive program of work was laid down. The need of additional apparatus was at once felt, and it was decided to erect a new channel. This channel had its axis horizontal. The total length was 20 ft. and the working channel, 4 ft. sq., was enclosed in a return channel 8 ft. sq. The air current was set up by a 6-ft. Sirocco fan, driven by a belt from an electro motor, which drew the air through the working portion of the channel and delivered it to the return channel. Guide blades were provided at the fan outlet to correct the rotary motion of the air, and layers of wire gauze were introduced at the inlet to the test channel in order to improve the uniformity of the flow across a section. The velocity was measured by a Pitot tube and Chattock tilting manometer, and reached a maximum value of 30 ft. per sec.

The balance was constructed in such a manner that simultaneous observations of lift and drag could be taken. The axis of the balance was horizontal, and for measurements of lift turned in ball bearings about a horizontal axis normal to its length. These bearings were carried in a fitting suspended on fine steel wires, allowing rotation of the balance through a small angle about a vertical axis for measurements of drag. The latter motion was transmitted to a right-angled bell crank whose plane was normal to that of the main balance arm. The horizontal limb of this bell crank constituted the drag beam upon which were placed weights to balance the wind forces. An oil dash-pot was provided which damped the oscillations of the two beams. One observer observed the reading of the drag beam and another regulated the speed of the air current and observed the reading of the lift beam.

This channel was in use till the year 1912, and the whole of the experiments carried out up to that date were made in it or in the 2-ft. vertical channel. The 4-ft. channel was not, however, entirely satisfactory, the flow being too unsteady to allow experiments to be carried out to the high order of accuracy which was desired. This result was mainly due to two causes; in the first place, the fan was of the centrifugal type, which is now known to be unsuitable for this purpose. There was found to be large pulsations in the pressure, a feature which appears to be common to fans of this kind. The second cause, which was of less importance, was that the air was returned to the intake of the channel in a disturbed condition.

It was accordingly decided to undertake a complete investigation into the conditions which affect the uniformity of the flow.

The design of the N. P. L. channels in their present form was based on these model experiments, of which an account is given in the 1912-13 Report of the Advisory Committee for Aeronautics. The success of the experiments may be judged from the fact that the latest of these channels was made almost an exact copy of the first, the only modifications being of minor importance, which were suggested by experience as likely to facilitate the taking of observations or to improve their accuracy. The criterion by which the merits of the various arrangements was judged was the nature of the variations of pressure difference in a Pitot and static tube of the standard N. P. L. pattern. The pressure was recorded by a special form of photographic gage which was constructed for these experiments.

The model experiments were carried out with a channel 6 in. sq., and this model was finally placed in a scale model of a bay of the engineering laboratory in which it was proposed to locate the actual channel.

A very exhaustive series of experiments was made with these models, and the following conclusions were finally arrived at:—(1) The air current should be produced by an airscrew of low pitch. (2) The air leaving the fan should pass into a distributor slightly larger than the fan and from three to four diameters long. The air should escape from the distributor through tubes of appreciable length (actually about 1.2 in. in the 4-ft. channels), which should distribute the air over as

*Koutchino Bulletin Fasc. I., 1916.

large an area as possible in constant quantity per unit area. (3) The smallest building in which such a channel may be housed to give satisfactorily steady flow is one whose dimensions are 6 x 6 x 15 channel diameters.

Modern Type of Channel

The new (or No. 1) 4-ft. channel was constructed on these lines. The channel, which has an over-all length of about 54 ft., is placed in a building 60 ft. long, 50 ft. wide, with an average height of about 20 ft. This building was the existing engineering laboratory, and was larger than the size laid down by the model experiments. That size was, however, adhered to in constructing the 7-ft. channel which was in view at the time the model experiments were being carried out. The No. 1 4-ft. channel is provided with a trumpet intake, and a honeycomb is placed in the parallel channel, near the entering end. The air passes through this honeycomb to the balance, which is located in the parallel channel some 16 ft. from the intake. At the end of the parallel portion a metal expanding piece is fitted, in passing which the section is changed from square to round. The circular part of the channel is very short, being just sufficient to house the airscrew, which is driven by a long shaft from an electro motor supported on the wall at the end of the channel. The air is delivered from the fan into the distributor, from which it passes at low velocity to the room.

A glazed door is provided through which models may be introduced, and a trapdoor is fitted immediately over the balance.

The fan has four blades 6 in. wide, and is capable of producing a current of 50 ft. per sec at 1350 r.p.m. The power absorbed at this speed is 8 hp., of which some 20 per cent is lost in passing the honeycomb.

Regulating resistances are provided, and tests can be made at any wind speed from 20 to 50 ft. per sec.

Types of Balances

The balance for the No. 1 4-ft. channel is of entirely different design from that of the original 4-ft. It was constructed with a view to carrying out the various complex experiments which were required as the study of the science progressed, and was arranged in such a manner that the interference of the supports with the model under test should be a minimum. Another difficulty was overcome which became more troublesome in the first balance as the size of the models increased, namely, the deflection of the balance, and airship models weighing about 30 lb. have been tested on the similar 7-ft. channel balance.

It is proposed to describe the first 4-ft. balance, and to refer later to the changes which have been made in the more recent balances.

The First Balance

The balance consists of two main parts, the lower of which carries the weighing arms and moment apparatus, and the upper of which projects upward through the floor of the channel and carries the model under test. The portion of the balance inside the channel is shielded from the wind by a guard, which covers also a portion of the spindle. This guard should not, however, be approached within about 3 in. of the model; in that position the interference due to it is usually negligible. The upper part of the balance can be turned upon the lower one, and the model thus rotated through any desired angle about the vertical axis from outside the channel, and without stopping the wind.

The balance is supported on a single steel point resting in a hollow cone. This cone is rigidly fixed to a heavy casting, which is firmly bolted to a cement bed, and is perfectly free from contact with the channel itself. The steel point is at the intersection of the center lines of the two weighing arms, which are set along and normal to the wind direction.

The balance has three degrees of freedom, and is arranged in such a manner that moments can be measured about the center line of each arm and about the vertical axis of the balance. A jockey weight is provided on each beam for fine adjustment. The third moment about a vertical axis was measured by means of the torsion of a wire, but this method has now been abandoned. There are two secondary arms placed diametrically opposite to the weighing arms, which carry balance weights, enabling the zero readings of the balance to be adjusted to values which will cover the range of forces to be measured. The arm opposite the lift beam is held by means of a strut and a spring in such a position that the drag beam is accurately along the wind direction. This strut, the point on which the balance rests, the center lines of the weighing arms, and the points of support of the two scale pans, are all in the same horizontal plane when the balance is in its mean position.

A movable weight is provided for adjustment of the sensitivity, and additional weights can be placed on two studs if necessary. A dashpot is provided at the lower end of the balance, and there is a clamp by means of which the balance may be locked in its mean position while adjustments are being made or the balance is out of use. Balance weights are also provided in the upper half, by means of which the center of gravity of the model and the part which rotates with the model may be brought into the vertical axis, about which the balance is turned. This adjustment prevents change of the balance zero when the angle of the model is varied. To prevent a stream of air flowing into the channel where the balance enters it, an oil seal has been fixed, which does not in any way interfere with the freedom of motion of the balance.

A force along the vertical axis of the balance was measured on an additional beam on which rested a rod passing through the trumpet of the balance and supporting the model. This method has now been superseded by one which will be described later.

A somewhat unusual arrangement has been adopted for detecting the departure of the balance from its zero position of equilibrium. The method of setting two cross-wires into coincidence is unsatisfactory, as it is not possible to place the cross-wires close together on account of the allowance necessary for angular motion of the balance during the measurement of moments about a vertical axis.

Parallax is, however, avoided by attaching to the beam a mirror bearing a line, and near it, but on the balance support, a cross-wire. The line and the cross-wire should be parallel, and with the balance in its zero position the cross-wire is adjusted till the line is midway between the cross-wire and its image in the mirror. The vertical distance between the wire and its image may be altered by adjusting the position of the eye, and this plan has been found to give higher accuracy than setting to coincidence. With a model whose weight does not exceed 2 or 3 lb. the balance is sensitive to .0001 lb., and much less (.00001 lb.) for very light models. For the highest accuracy the position of the line on the beam is observed by means of a microscope.

The Airscrew Balance

The airscrew balance* described differs very little from the main balance. It has two weighing arms and is supported on a single point, rotation about a vertical axis being prevented by a strut and C spring in the manner previously described for the main balance. A dashpot is provided to damp out oscillations, and as it cannot be placed further from the point of support than the roof of the channel, it is made to serve also as an oil seal. The speed of the airscrew is usually measured by electric signals from a toothed wheel driven from a worm on the airscrew shaft. In experiments in which it is important to maintain the speed at a predetermined value the worm gear is replaced by a commutator which enables a certain number of electric contacts (the number can be varied at will) during each revolution. The pulsating current thus obtained is passed through an electrical frequency meter which gives an instantaneous indication of the speed at any convenient distance from the balance. An electro motor for driving the airscrew is carried on the upper part of the balance, current being supplied through mercury cups in order to leave the balance perfectly free. The airscrew is driven by a belt passing through a slit in the roof, which allows the whole balance to be turned through an angle of 40 deg. on either side of the position of symmetry. The arm, which projects downward into the channel, carries at its lower end ball bearings for the airscrew shaft, the axis of which is coincident with the center line of the channel. When the airscrew shaft is along the wind the thrust is measured on the arm parallel to the wind and the torque on the one perpendicular to the wind. When the shaft is inclined to the wind the thrust is still measured on the arm parallel to the airscrew shaft, but the arm perpendicular to the shaft measures the torque and the lateral force on the airscrew. These two quantities are determined from observations made when the model is inclined

* Rpt. Adv. Comm. for Aero. 1913-1914, p. 291.

at equal angles on either side of the down-wind position. The torque will be given by the mean of the two readings and their difference will be equal to twice the lateral force.

The balance in this form has been described in the 1913-14 report of the Advisory Committee for Aeronautics. A large number of experiments have been carried out since that date, and a new balance, the design of which has been modified in several important respects, is now in course of construction for the 7-ft. channel.

Later Channels

Since the No. 1 4-ft. channel there have been constructed the 3 ft. and No. 1 7-ft. in 1914, and in the new aeronautics building the No. 2 4-ft. and No. 2 7-ft. in 1916.

The changes in design have been mainly in the balance; those in the channel consist in substituting slots for square holes in the distributor, and in turning back the trumpet mouthpiece till it touches the parallel part of the channel. The latter step was taken to prevent the formation of vortices, which were found to be formed at the edge of the original trumpet.

The speeds also have been increased, the highest values for the various channels being: No. 1 4-ft., 50 ft. per sec.; 3-ft., 60 ft. per sec.; No. 1 7-ft., 65 ft. per sec.; No. 2 4-ft. and No. 2 7-ft., 80 ft. per sec. In connection with the high speed attained in the two newest channels it may be remarked that they are very noisy, and observers usually find it necessary to protect their ears with ear-defenders or cotton wool against the very intense vibrations which are set up over about 60 ft. per sec. The author is informed that the Kingsnorth channel, in which a speed of 100 ft. per sec. is attained, and in which the fan is driven by a petrol motor, is much less noisy, and it has been suggested that the vibrations of the N. P. L. channels are due to the laths of the distributor.

The newer channels also have an additional honeycomb between the balance and the airscrew. This has the effect of entirely preventing spin of the air due to the rotation of the airscrew, but causes an appreciable increase in the resistance of the channel. It is probable that guide blades of lower resistance would be equally effective.

Two important changes have been made in the design of the balance—namely, in the apparatus for measuring moments about a vertical axis and in the method of determining forces along that axis.

The method of measuring vertical force by a rod moving relatively to the balance has been abandoned in favor of the observation of the change in effective weight of the whole balance. No details of the arrangement can be given at present, but it may be stated that on the balance of the No. 2 7-ft. channel forces can be measured with ease to 0.001 lb., which is the 1/100,000th part of the total weight of the balance.

German Technique in Aerial Armament*

By Jean-Abel Lefranc

Victory in aerial warfare, as in warfare on land and sea, consists in preventing the adversary from executing his designs, either by preventing him from continuing the fight or by destroying his matériel and personnel until he can no longer resist.

Aerial fighting consists of a series of actions, by which the combatants endeavor to obtain from their materiel and arms the best possible use to destroy the power of the enemy, who on his side tries to secure the same from his matériel.

The actions, which have as their goal the choice of most favorable time, best position, most powerful battle formation, etc., are the elements of aerial combating tactics.

The deeds which result from the qualities of the airplane, armament, speed, maneuvering ability, altitude, etc., are the elements of technique.

These tactical and technical elements of aerial warfare constitute two kinds of factors which, while quite different, are intimately connected.

The battle commences with a series of tactical actions by means of which the assailant tries to attack his adversary by securing the best chances for himself; such as surprise, advantage of greater height, group attacks, attacks from the rear, etc. The combat terminates through the technical contest between the two battle planes present, until one or the other is destroyed or takes to flight.

It is evident that the preparative tactical actions of a

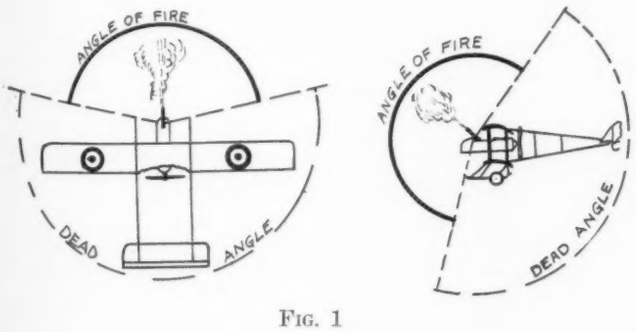


FIG. 1

combat cannot be executed unless the technical characteristics of the airplane permit it. The freedom to engage or decline combat, for example, implies a superiority in speed.

The fact that an airplane possesses the four technical superiorities of an ideal fighting plane, that is, speed, armament, maneuvering ability and quick climbing, permits its pilot to gain all tactical advantages in the fight.

An airplane can possess one of the technical superiorities without that resulting in its being able to gain any tactical advantage. For example, a 37 mm. rapid fire gun was carried

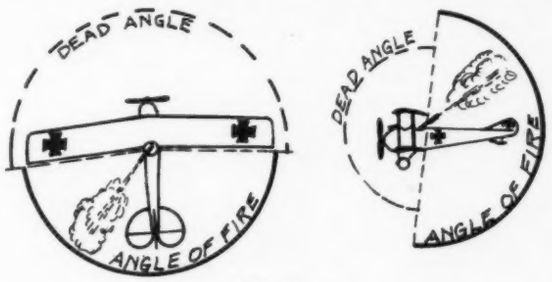


FIG. 2

by the Voisin gunplanes, and these machines possessed a superiority of armament over most of the enemy planes of that period; nevertheless, the Voisin having little speed or manageability and being practically unable to surpass 2500 m. (8200 ft.) altitude, it was practically impossible for it to ever take advantage of its armament.

The enemy airplanes profited by their speed and their manageability to attack this gunplane without placing themselves in its very limited field of fire; their superiority of altitude permitted them to decline combat by climbing 500 m. (1640 ft.) higher.

The technical elements are identical for all planes of the same type, but their utilization in combat, that is to say, their application to tactical actions, varies with the knowledge that each pilot may have in regard to each particular case.

The good usage of tactical elements depends to such point upon their intelligent application by the pilot that one has often seen planes, inferior from the point of view of technique, speed, armament, manageability, etc., as the old 1915 Farman, obtain, due to the ability and courage of their pilots, real tactical successes, going as far as complete victory over quicker, better armed, and more manageable adversaries, such as 1915 Aviatiks.

Particularly, our "Aces" are magnificent examples of good tactical use of material. As a general rule, we must, however, admit that technical superiority is the best way to attain tactical superiority in combat. Material superiority has been the principal foundation of German tactics in terrestrial combat.

The relative importance of each of the technical factors of

* Translated from *La Nature* by Robert E. Bassler.

aerial combat varies according to the task asked of the planes.

For a battle plane, the four large factors in order of importance are speed, manageability, armament and altitude. The captured German pilots admit that the superiority of the Nieuport and Spad over the fighting Albatros lies especially in their extreme manageability, the other factors being practically equal.

A spotting plane, a photographic plane, a small bombing plane, a protecting plane, which because of their specializa-

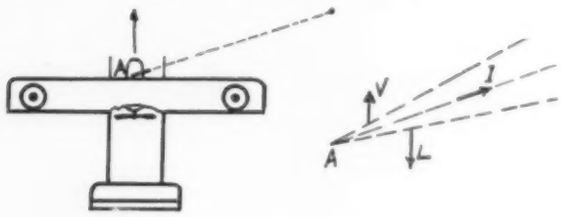


FIG. 3

tions cannot be fast enough to avoid combat, should be conceived to possess in addition to their tasks, technical superiority in defensive armament; the manageability and speed factors become elements of lesser importance than in the case of a battle plane.

The heavy night bombing plane requires quite different technical qualities, such as great bomb capacity, radius of action, landing ability, etc.

The actual speed of the French and German pursuit planes varies between 180 km. and 200 km. (115-125 miles) per hour. This speed could easily be higher if the planes did not require a plane area sufficiently large to raise their 1000 kg. (2200 lb.) from 5000 to 6000 m. (16,000-20,000 ft.) and to land on any ground, without capsizing.

The actual speed of artillery, photographic, light bombing and protecting planes is about 125-150 km.p.h. (78-93 m.p.h.), and that of the night planes can easily remain 90 to 120 km. (56-75 miles) per hour, if the conditions of capacity demand it.

The maneuvering qualities of a plane are functions of judicious distribution of the different forces to which it is sub-

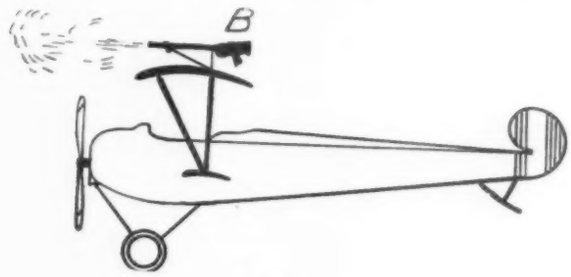


FIG. 4

jected, such as elevating force, weight and forces resulting from the use of the controls.

The armament is not the least of the decisive factors of the battle, as it is the one which destroys the power of the enemy.

I. At the beginning of the war, at which time aviation still played a relatively minor role and had not assumed the importance of an indispensable factor of victory, the necessity of the "Mastery of the Air" had not as yet made itself felt and aerial combat was a rare event.

The planes went out armed with carbines or rifles guarding themselves most of the time from attack. Then little by little, each desiring to keep the secret of their preparations, but nevertheless seeking to find out those of the enemy, combats became frequent. It was necessary to quickly mount machine guns on chance supports which it became necessary to perfect rapidly.

It was the first period of aerial combat which hardly took but one form of armament. The planes, all two-seaters, were armed with a machine gun operated by the passenger.

The majority of French planes were in the early days of the pusher type, and so possessed in the rear a considerable dead angle. The machine gun, generally mounted on a pivot at the front of the body, right or left, made the defense of the plane difficult from the sides. (Fig. 1.)

The German planes, having their propeller in the front, had their machine gun in the rear, on a pivoting turret permitting a rapid shifting of the fire to the right or left.

The dead angle of fire was thus in front and underneath the pilot's range of vision. (Fig. 2.)

One was amazed to find how often fierce battles at close quarters had hardly any practical results except for a few bullet holes in the wings.

In the first place, a small amount of munitions was carried, not more than a few belts of 25 cartridges or a roll of 100. The mechanism of the machine gun was very delicate, the supports were very impractical, and moreover the firing precision was most extraordinarily defective.

The causes of this inaccuracy were many; they were due principally to sighting errors due to the relative speed of the two combatants; due equally to the considerable vibrations of the too light machine guns which prevented all accurate sighting; due to the inconvenient position the machine gunner had to take to shoot in the direction *O*, for example, Fig. 1; due

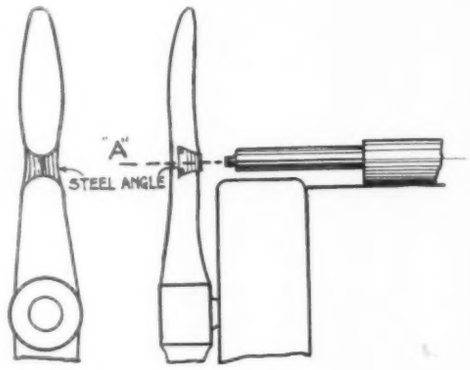


FIG. 5

to the difficulties in handling heavy armament in winds of 100 km.p.h. (62 m.p.h.).

Then again, the trajectories of the shots effected from the sides towards *O* (Fig. 3) were deflected by new forces; the initial lateral speed produced by the speed of the plane (Force *V*, Fig. 3); the side wind force produced by this same speed on the projectile (force *L*, Fig. 3); two forces *V* and *L*, which unite with the initial speed *L* of the bullet and deflect the trajectory.

The height again does not give any precise indication for armament shooting in a nearly vertical position, up or down, and also rarely in a horizontal plane.

The firing distances are generally under 400 m. (1300ft.), and if this element of error is to be noted, one must still add it to the preceding causes of error in order to show the great difficulty of aerial fire.

II. The second period comprises the organization of armament aboard the planes which have been specialized in their accommodation.

Three principal formulae have been adopted by us as by our enemies:

1. Shooting forward with a fixed machine gun firing above or through the propeller (single-seater);
2. Shooting forward with a fixed machine gun as in the first case, but with the addition of a machine gun mounted *en barbette* and firing to the rear (two-seater);
3. Shooting forward and aft with machine guns mounted on independent gun rings (barbettes), and firing under the body with a machine gun on a pivot (three-seater).

The builders have been brought to study the formula of fixed fire toward the front through or above the propeller, at first to allow the monoplanes to become battleplanes, then to avoid the above mentioned drawbacks for the fixed machine guns on barbettes or pivots higher up.

The main advantage of the fixed machine gun is obviously to permit the pilot of the monoplane to pilot it while using his armament.

The machine gun fires in the axis of the plane; the pilot sights his object with his entire plane; the sighting is effected by a sight strictly parallel to the machine gun.

In the second place, the machine gun being fixed and consequently integral with the entire mass of the plane, all the vibrations due to firing are done away with.

Other advantages resulting from this disposition are: excellent position of the pilot gunner; no more deviation produced by the lateral wind (force *L*, Fig. 3) and by the initial speed of the plane (force *V*, Fig. 3); this force *V* is transformed into a supplement of the initial speed of the bullet.

1. The first application of the fixed machine gun firing above the propeller dates from the appearance of the Nieuport pursuit biplane. (Fig. 4.)

There the machine gun was mounted on the upper plane and fired over the propeller. The principal inconvenience of this position, other than the additional head resistance, was the difficulty experienced in reloading the gun.

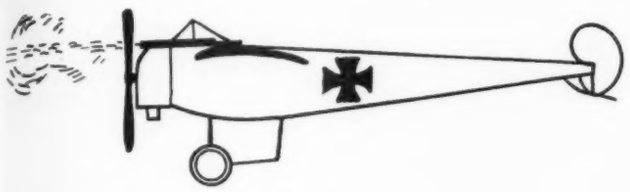


FIG. 6

In order to reload the machine gun, the pilot made it pivot from top to bottom in *B*, and could then take out the empty drum and put in a new drum of 47 cartridges. These 47 cartridges were fired at a rate of 300 to 400 shots per minute.

One can easily imagine the difficulties which the pilot experiences who, in addition to the piloting of his plane, has to fire and reload his gun. In fact, if the pilots of our first Nieuports did not obtain decisive results with their first drum, they were obliged to withdraw from the fight.

The second application of the fixed machine gun was shooting through the propeller, used for the first time by Garros. The principle of this application seems extremely curious at first sight. The machine gun shot at its normal rapidity; in order to avoid letting the bullets strike the blades of the propeller, two extremely hard steel guards were fitted on the blades at the same point where the bullets passed. (Fig. 5.)

The bullets which hit the guards were deviated and lost, but the others passed tbetween the blades and continued their trajectory toward the objective. The percentage of bullets lost would have been less than 7 or 8 per cent, therefore negligible

This system was, however, abandoned when it was found that it caused the airplane a loss of speed of 20 km.p.h. (12

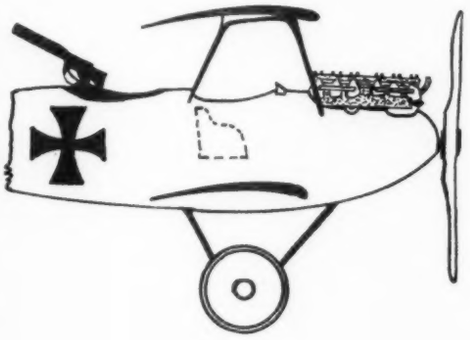


FIG. 7

m.p.h.). The propeller after its transformation lost a portion of its tractive force owing to the thinning out of the blades at *A* and the decreased pitch of the airscrew which had to compensate for the resistance of the guards, and thus insure the normal speed of the engine. (Fig. 5.)

This technical superiority of armament could not compensate in this battle plane for the technical inferiorities caused by the lack of speed.

The third application of this formula was brought out by the Germans at the time of the appearance of their single-seater Fokker battleplane. (Fig. 6.)

There the fixed machine gun shoots through the propeller but is regulated by the motor, its normal performance being synchronized with that of the motor. The propeller turning at 1400 r.p.m. and having two blades, 2800 blades per minute will therefore pass before the barrel of the machine gun; it is necessary that the regulation of fire be sufficiently precise to permit the bullets to pass in the intervals (60/2800 or 1/46 of a second).

The firing of the machine gun by synchronization with the

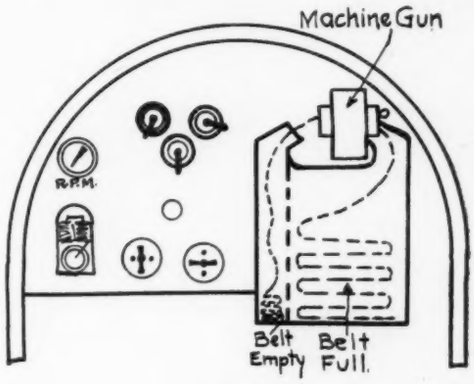


FIG. 8

motor is effected by a rigid shaft and transmission gear (Fokker, Albatros, D. Halberstadt, etc.) or by flexible transmission, (Albatros C., Rumpler C.). The pilot throws his armament in gear at will by leaning on the Bowden handle. This system is the adopted disposition of most of the French, Allied, and enemy airplanes.

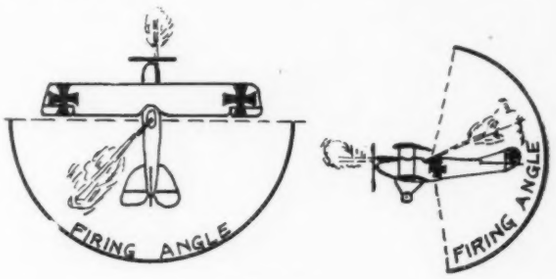


FIG. 9

The machine gun is covered by the hood of the motor (Fig. 7); it is easily loaded, and the releasing of the brake is also easy. The cartridge boxes can contain belts of 800 to 1000 cartridges per weapon.

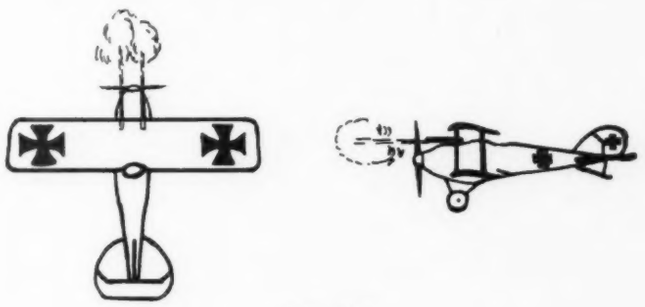


FIG. 10

The battle planes are generally single-seaters, in order to obtain a more manageable and speedier plane, that is, one able to rise to a greater height more quickly.

The German series, Albatros D I, D III, Halberstadt, Roland D, Ago D, Fokker D, mount two fixed machine guns firing through the propeller, each gun being supplied with 1000 cartridges. (Fig. 10.)

2. Another system of armament (Fig. 9) exists for slower two-seater planes, assigned to missions of regulating artillery fire, of taking photographs, and eventually of making small bombardments. This series corresponds to the Albatros, Rumpler, Aviatik and L.V.G. planes, all the "C" two-seater series, having a speed not exceeding 140-160 km.p.h. (87-100 m.p.h.).

Their armament is defensive; a forward machine gun firing through the propeller, serves in particular for attacking; another machine gun in the rear is mounted on a turret. We have adopted these same dispositions for our planes of the corresponding series.

The forward machine gun generally corresponds to the type used by the infantry. The after machine gun is a much lighter weapon. The feeding of fixed machine guns is effected by belts, that of the movable machine guns by rolled bands on spools or by drums.

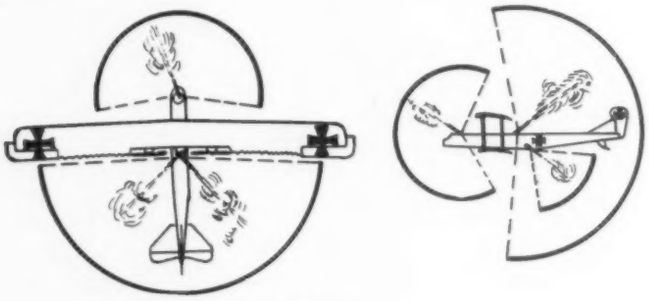


FIG. 11

3. The third system of armament is the one applied to the three-seater plane, either for protection or bombing.

This type of plane is essentially defensively armed; in order to clear the front of the body, the plane is fitted with two motors or two propellers. Such are the Gotha, Friedrichshafen G, AEG.G., and Rumpler G. This series is comparatively recent; their speed seems to be about 150 km.p.h. (93 m.p.h.), a speed equivalent to the planes used for regulating artillery fire and photographing (series C).

The three-seaters appear destined to protect the lines, to protect spotting planes or to execute heavy bombardments.

Their armament comprises a movable machine gun on the forward turret, a movable machine gun on the rear turret and a movable machine gun on a pivot, the latter firing through a trap door under the body. (Fig. 11.)

These strongly armed planes are difficult to attack, for the pilot who engages them finds himself in any quarter under the fire of one of the machine guns. The tactics against these fortresses is evidently to tire the rear machine gunner, who

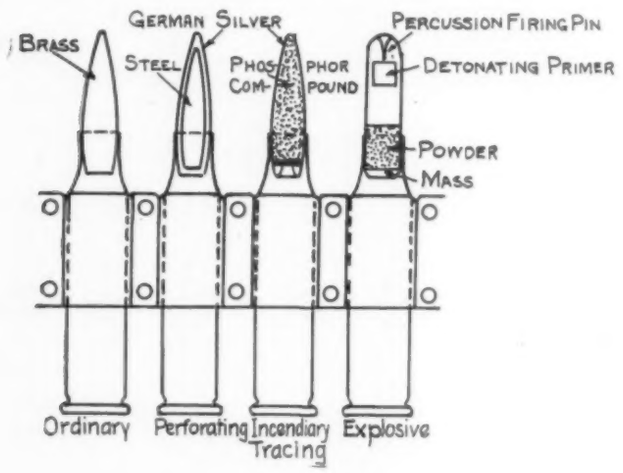


FIG. 12

is compelled to pass constantly from his turret to his lower trap door, if the battle plane harasses him by its aerobatics.

This heavy weight machine is bound to be greatly developed, for the protection of the medium-sized planes becomes more and more difficult, and long distance bombing expeditions become necessary to paralyze certain industries or to execute reprisals on enemy cities.

While the adoption of a fixed machine gun firing in the axis of the plane does away with a part of the forces which disturb the firing accuracy, all these difficulties must be overcome in the case of movable machine guns. Furthermore it is necessary to correct the imprecision of fire of fixed machine guns which result from the relative speeds of the planes.

The necessary correction is made by means of a special sighting apparatus, which automatically calculates the angle at which the enemy plane is seen by the gunner. These sighters are very interesting but cannot be actually described.

The armament formulæ herein described are those which we and our enemies have applied on the majority of airplanes. In reality, there are some other formulæ in use, on planes on trial or on rare specimens destined to disappear.

The general tendency is to anticipate planes with identical characteristics for the same mission.

The following table gives a general outline of the main features of the German airplanes presently commissioned:

BATTLE OR PURSUIT PLANES

One engine of 200 hp.; single-seater biplanes, 25 sq.m. (270 sq. ft.) surface area; two machine guns firing through the airscrew (Series D).

ARTILLERY SPOTTING, PHOTOGRAPHY, AND SHORT RANGE BOMBING PLANES

One engine of 220-260 hp.; two-seater, 40 sq.m. (430 sq.ft.) surface area; one machine gun firing through the airscrew, and one mounted on a turret (Series C).

PROTECTION AND LONG RANGE BOMBING PLANES

Two engines, 500-550 hp.; three-seater, 100 sq.m. (1080 sq.ft.) surface area; one machine gun forward, on a turret; one machine gun aft, on a turret, and one machine gun pivoted underneath the body (Series G).

The munitions presently employed by the Germans are the following: Ordinary bullets, incendiary, perforating and explosive bullets. (Fig. 12.)

The difficulties which our enemies no doubt encounter in manufacturing such special ammunitions force them to use in the majority of cases ordinary bullets.

The incendiary and tracer bullets are hollow, and contain an incendiary matter of a phosphor base. They leave behind them a luminous train, destined to ignite balloons and gasoline tanks and to permit the gunner to rectify his fire.

The perforating bullets are composed of a hardened steel center, with a covering of German silver. They are destined to perforate the metallic portions of planes, and in particular the motors.

Explosive bullets are carried in belts and drums in the proportion of about 10 to 15 per 100. They have the shape and composition of a small shell, a small plunger forming a percussion firing pin over a detonating primer. All the special bullets have trajectories which differ sensibly from the trajectory of ordinary bullets, their weights and their forms accounting for this divergence. Neveretheless, in combats lower than 300 m. (1000 ft.) it is not necessary to use special sights.

Aeronautical Patents

DECEMBER 18, 1917

1,250,124—To Ivan Anderson, Hempstead, N. Y. Airship.
1,250,213—To John Onofrichuk, Atlanta, Ga. Safety Device for Aviators.
1,250,262—To Franz Wondra, Schenectady, N. Y. Airplane.
1,250,263—To Robert Yates, Passaic, N. J. Airplane Propeller.
1,250,530—To Minatojo Sydney, Charlestown, Mass. Flying Machine.
1,250,649—Karl H. Piesch, New Orleans, La. Airplane.
1,250,749—To Frederick C. Wright, Halifax, Nova Scotia, Canada. Self-stabilizing Airplane.

DECEMBER 25, 1917

1,251,414—To Fred Peterson, Amsterdam, N. Y. Apparatus for Dropping Bombs.

ISSUED JANUARY 1, 1918

1,251,896—To Gustave Krogel, Paterson, N. J. Safety appliance for airplanes.
1,252,339—To James M. Funk, Ottawa, Ill. Airplane.

ISSUED JANUARY 8, 1918

1,252,904—To Andrew M. Hirmer, Millvale, Pa. Flying machine.

ISSUED JANUARY 15, 1918

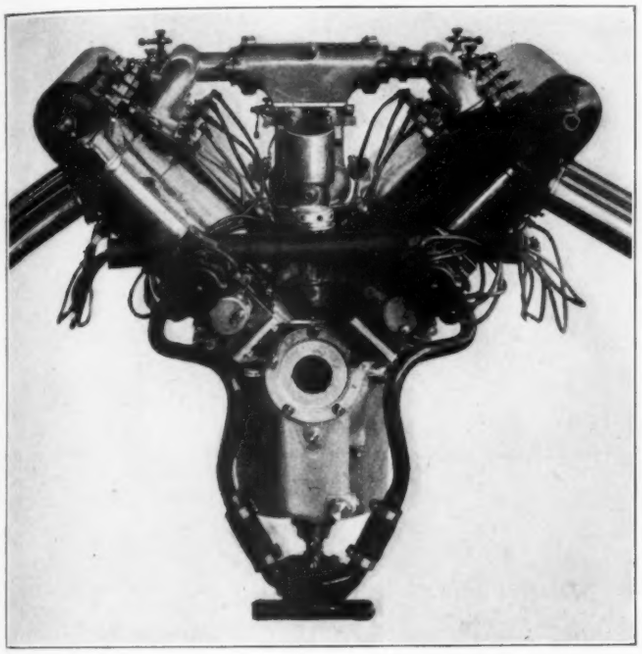
1,253,937—To Hippolyte Marius Cheron and Jean F. Berrier, San Francisco, Cal. Flyingmachine.

ISSUED JANUARY 29, 1918

1,254,898—To Norris H. Frost, West Hoboken, N. J. Self launching airplane.
1,254,947—To William A. Uttz, Kansas City, Mo. Parachute-equipped airplane.
1,254,982—To René Caudron, Issy les Moulineaux, France. Controlling device for airplanes.
1,255,042—To James H. Pearson, Bloomfield, Ind., assignor of one-third to James Hasler and one-third to Charles E. Fuller, Bloomfield, Ind. Airship.

Bids Asked for Five Postal Airplanes

The Post Office Department has taken the first step towards establishing commercial aeronautics in this country. On Feb. 12 bids were called for by Postmaster-General Burleson for the construction of five postal airplanes to be used in the establishment of a regular daily aerial mail route between Washington, Philadelphia and New York. In this connection arrangements have been perfected with the War Department to obtain the release of a sufficient number of engines for equipping the machines of the Post Office Department. It is pointed out by those in authority that this aerial mail route is not intended to serve as an experiment; as a matter of fact authorization for its establishment was withheld by the postal



THE 150 HP. HISPANO-SUIZA AERO-ENGINE

authorities until every assurance was forthcoming that once created the route would be a permanent success. Before calling for bids the Post Office Department officials held several conferences with the National Advisory Committee for Aeronautics, and particularly with its sub-committee on Civil Aerial Transport, in order to make sure that the requirements of the service would be fully met; and, the practicability of the plan having been satisfactorily demonstrated, it was decided to organize and maintain the first American postal airplane route as a permanent institution. For this purpose an appropriation of $100,000 has been made by Congress. As soon as additional appropriations may be forthcoming the Post Office Department intends to start upon expanding its aerial mail system.

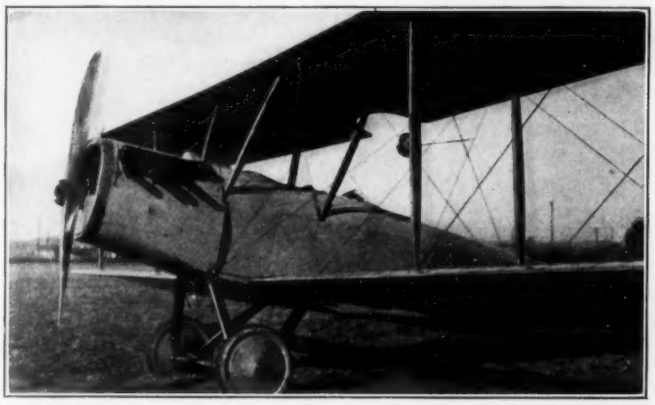
Present plans call for the carrying by airplane of 300 lb. of first class mail a day each way; for this service Congress will be asked to immediately fix new postal rates, not exceeding 25 cents per ounce or fraction thereof. The postal authorities are confident that this seemingly high rate, which is necessary to make the service self-sustaining, will not deter prospective users of the aerial mail, for these will be prompt to realize the advantages accruing from the considerable amount of time saved thereby.

Heavy first class mail runs about twenty-eight packages to the pound and the lighter packages about fifty to the pound. In mixed mail it is safe to count on forty-two packages to the pound. The airplane mail carrier will be able to transport about 12,000 pieces on each trip. If these are charged for at the rate of 25 cents an ounce with 25 cents as the minimum charge the revenues would be at least $3,000 a trip if only commercial mail is handled. There will be a great deal of Government mail, however, which being carried under frank will reduce the receipts.

The postal machines are to be capable of flying, fully loaded, at a maximum speed of 100 m.p.h. a distance of not less than 200 miles. The specifications call for 150 hp. Hispano-Suiza engines, which are manufactured on a quantity basis by the Wright-Martin Aircraft Corp. of New Brunswick, N. J. These engines carry as standard equipment the Dixie magneto manufactured by the Splitdorf Electrical Co.

The distance between Washington and New York being 190 miles in air line, it is expected that air-borne letters leaving Washington will reach New York in not more than three hours. This is a liberal estimate which takes into account losses of time due to atmospheric conditions and to stoppage at Philadelphia. With telephone and telegraph lines to and from Washington congested, the aerial mail route may well be expected to furnish service at least on par with the wire communications.

Sealed proposals, subject to the usual conditions, will be received at the office of the Purchasing Agent, Post Office Depart-



THE HISPANO-SUIZA ENGINED WRIGHT-MARTIN MODEL V BIPLANE

ment, Washington, D. C., until 2 o'clock p.m., Feb. 21, at which time and place they will be publicly opened, for furnishing and delivering f. o. b. factory the articles named below.

Bidders have the right to be present, either in person or by attorney (Sec. 63, P. L. & R.; Sec. 3710, R. S.), and to examine and inspect all bids (33 Stat. L., 440). The Department reserves the right to reject any or all bids.

The Proposals

The proposals call for bids on the following items:

Five airplanes, complete, capable of carrying 300 lbs. of mail a distance of not less than 200 miles, non-stop, at a maximum full load speed of 100 miles, minimum full load speed 45 miles, climbing speed 6,000 feet in ten minutes, and equipped with a 150 hp. Hispano-Suiza engine.

Also spare parts, as follows: 1 landing gear complete, 1 complete set of wings, including center section and interplane struts; 1 complete set of lower wings, 5 propellors, 1 elevator, 1 stabilizer, 2 rudders, 2 fins, 3 tail skids complete, 3 landing gear axles, 2 sets of 2 landing gear wheels complete, 2 sets of 2 rubber shock absorbers for landing gear, 2 engine beds, 2 engine bed plates, 2 radiators with fittings.

The parts mentioned must conform to the specifications for the airplanes to be furnished.

The contractor will further be required to build and hold in reserve a sixth airplane of the same dimensions, to detail to the Post Office Department for three months one satisfactory supervisory official, and to try out under the direction of the Post Office Department such suitable aviators and airplane mechanics as the department may need in the operation of the said airplanes.

It is announced that the contract will be awarded to the bidder whose airplanes have stood satisfactory service test in the War or Navy Departments, and that airplanes and parts are to be delivered as may be designated by the Post Office Department, at New York, Philadelphia and Washington not later than April 25.

The step taken by the Post Office Department is of such a momentous nature that its ultimate influence upon our postal service can hardly be overestimated. One already visualizes, through the expansion of the first aerial mail route, the linking of our great centers of population by the agency of the swift aerial messenger, and the manifold economic advantages such an organization will bestow upon us. Eventually, and possibly the time is not so far distant, passenger airplane lines will be put into operation, either by private enterprise or by Government initiative, and thus the foundation will be laid for the swiftest public transport service the world has ever seen and benefited by.

The proposed creation of the first American postal airplane line has still another significance. It shows that the Government is fully satisfied that the production of aircraft engines is now proceeding on such a scale as to ensure a wholly adequate supply for our military needs. Were this otherwise, it would seem hardly likely that the organization of a commercial air service would be contemplated in the midst of the World War. It furthermore tends to show that the Government is not waiting for the end of the war to utilize in the pursuit of peaceful purposes the enormous aeronautical matériel and personnel it is gathering up for the victorious prosecution of the war. This wise and farsighted step should be hailed as a valuable indication of the Government's determination to eventually second, with its full power, the efforts the aircraft industry is bound to put forth after the war in the field of commercial aeronautics.

Italy's Plans for Postal Airplane Routes

In view of the proposed creation by the U. S. Post Office Department of a postal airplane route between New York and Washington considerable interest should attach to enterprises of a similar nature which are now being attempted abroad. Italy, more than any other country in Europe, appears to display in this respect a particularly farsighted policy; her progressive views on the problem of commercial aeronautics and her endeavors in this field should therefore attract wide and more than passing notice.

Last summer the Italian Post Office Department established an experimental seaplane mail service between Continental Italy and Sardinia. Although little has come to light about this enterprise, the results attained must have been promising enough, for Italy now proposes to organize an aerial mail service between the mother country and her North African colonies. Such is the announcement Signor Eugenio Delmati, Director-General of the Italian Post Office Department, makes in the *Rivista dei Trasporti Aerei*, an Italian aeronautical magazine specially devoted to aerial transportation.

LOCATION OF ITALY'S PROPOSED AIR ROUTES

Daily performances of airplanes, says Signor Delmati, prove to all intents that the novel vehicle of locomotion has been so perfected as to its constituent parts, but especially in regard to its motive power, that truly surprising results are being obtained nowadays in matters of safety and efficiency of aerial navigation. These results naturally lead one to seriously consider the possibility and advisability of employing airplanes, not only after, but even during, the war for the purpose of supplementing or replacing certain means of present day transport by a substantially swifter public agency.

The Italian Post Office Department is said to follow with the most sympathetic interest the technical and practical progress achieved by airplane constructors, this with the ultimate view of utilizing such progress in the furtherance of its plans for a modernization of its mail services.

As a matter of fact no service requires faster means of locomotion than the mail service; this is particularly the case today when the feverish commercial and intellectual activity of the modern countries pretends to exert its activity over the widest possible field of action in the shortest possible time. For this purpose the various telegraphic, telephonic, and radio communications are obviously insufficient, and may rather be considered as being of an introductory character insofar as they prepare the addressee for the much more detailed written information which follows by railroad or steamship.

Recognizing the great possibilities airplanes offer in the organization of mail services, the Italian Post Office Department has encouraged Italian aircraft constructors to submit tentative plans and proposals for the organization of a regular postal airplane service. These proposals are now being examined by a special commission which was created for investigating the possibility of establishing a system of aerial mail routes.

It is but natural that Italy should pay the greatest attention to the problem of public aerial navigation, says Signor Delmati. At the time when not only France and England, but even Sweden and Norway are actively preparing for the creation of passenger and postal air lines, Italy cannot, without incurring the gravest responsibility, leave the solution of this problem to private initiative. This will be readily understood if one considers the predominant situation the Italian aircraft industry holds in the world, which is due to its large airplanes as well as to its aircraft engines of national manufacture. This situation, if properly encouraged, will enable Italy to victoriously resist foreign competition. To this criterion should be added the particular geographic position of Italy, by virtue of which it is bound to become the center of all aerial routes which will eventually lead from Northern Europe to the Mediterranean basin, and hence to Asia and Africa. In Signor Delmati's own words "Italy must in time conquer the right to serve Europe as a carrier of aerial mails and passengers to all countries of the Orient."

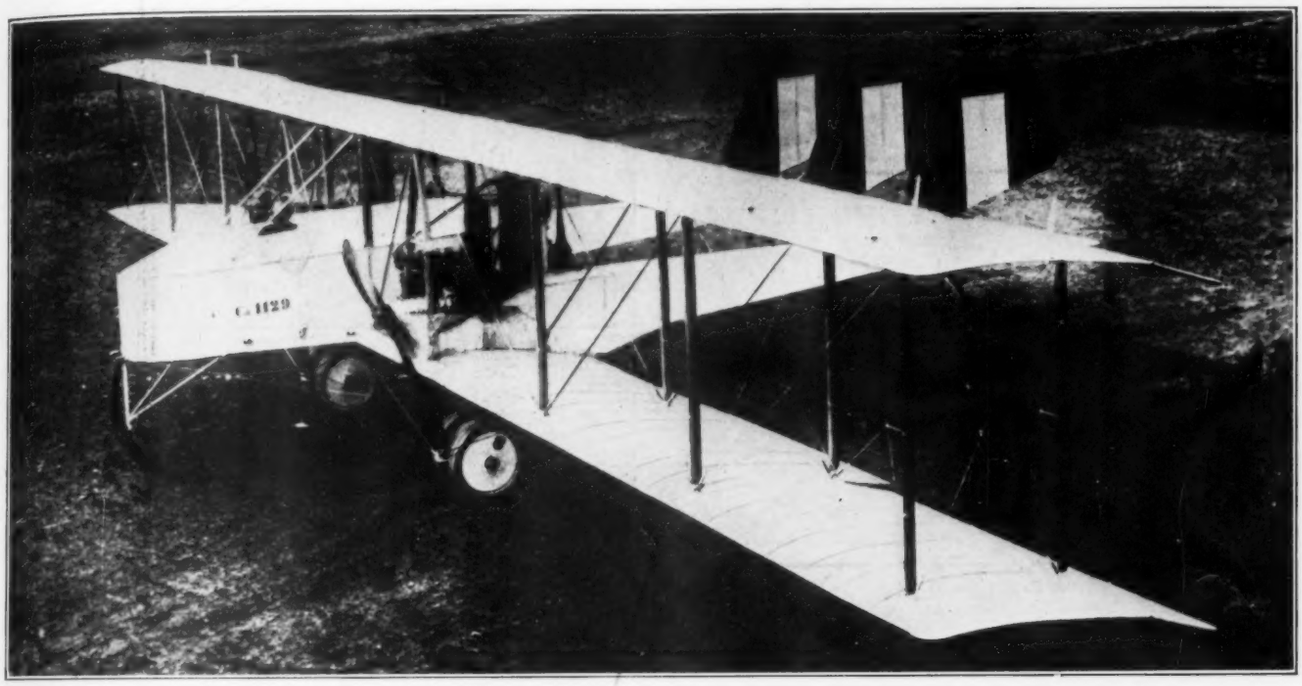
In view of the above considerations it is however necessary that public opinion be so directed as to properly grasp the present limitations of the problem. To say that airplane

lines may, at the present moment, be substituted to all other means of transportation simply shows a total lack of knowledge of the difficulties surrounding the problem.

Thus, for a certain time the coming public air services will be limited to linking up localities which possess no other modern means of transport, or which are so far distant from one another that the creation of an air line will serve to materially reduce the time of travel. In other words, before one may elaborate a complete system of aerial routes, such as may ultimately be substituted to presently existing railway and steamship lines, it will be necessary to organize first those aerial routes which may prove of substantial advantage to the

to Lybia, and about 2,500 kg. on the way back. For a daily air service between Naples or Syracuse and Tripoli airplanes having a cargo capacity of 600 kg. would thus seem to assure a satisfactory mail service.

While our aireraft industry appears to be fully able to cope with the problem of producing such machines, proceeds Signor Delmati, it should not for a moment be believed that seaplanes of the type used in the experimental postal air route between Italy and Sardinia may be of any value in the projected air service with our colonies. The cargo capacity of these machines was so limited that their value for mail purposes was rendered wholly insignificant.



A Successful Italian Cargoplane: the Three-Engined Caproni
Central News Photo Service

mail service and to travelers on account of the saving of time effected. After this first, and most important problem will have been resolved one will be able to investigate how far the needs of large localities for swift transportation *per se* may warrant the creation of additional air lines between large, and possibly not very distant, cities.

Considering the problem of public air navigation from this, essentially practical angle, one may now examine the possibilities of, and the advantages accruing from, the creation of a postal air service between Italy and her African colonies, Tripolitania and Cyrenaica.

For a comparison, one may take as a basis of this study the mailboat service such as it existed prior to the war, for lack of tonnage and difficulties of navigation due to the submarine menace have since greatly reduced this service. The same remark applies to the railway service, with which the future air mail is going to be connected, for this too has suffered a substantial reduction.

The steamship lines between Italy and Lybia (Tripolitania and Cyrenaica) made four trips a week, the time employed between Syracuse and Tripoli being 27 hours, while the railroad trip from Turin to Syracuse required 36 hours, which is to say that a total distance of about 2,000 kilometers could be covered in not less than 63 hours. By covering the same distance with an airplane and a seaplane having a horizontal speed of 140 km.p.h. the time could be reduced, including the time required for stoppage at ports of call, to about one-third that employed by rail and steamship.

To be of practical use the airplane mail route should be able to carry all light mail matter, which is at present carried by the mailboats, such as letters, postal cards, money orders, samples, newspapers, and magazines. Parcel post should be excluded from this service for the present time. In normal times about 4,000 kg. of mail are carried weekly from Italy

The steamship lines between Italy and Cyrenaica which made only one trip a week, employed, one, five days to cover about 1,400 km., and the other, 54 hours to cover about 700 km. An airplane mail service could cover these two distances in from twelve to fifteen, and from five to six hours respectively. The amount of mail carried between Italy and Cyrenaica approximately equals that carried to and from Tripoli; therefore the cargo capacity required for this service is essentially the same as the one set forth above.

Once the outlined aerial mail routes would link Lybia to her mother country its manifold advantages would soon become obvious, particularly in view of the shortage of tonnage which it will take quite some time to replace with new constructions, even after the war is terminated. To increase the usefulness of the trans-Mediterranean air lines it would seem necessary to interconnect the principal cities of Tripolitania and Cyrenaica by local airplane lines; such a service could be run to obvious advantage by machines having a much smaller cargo capacity than the ones above considered. For this purpose a large number of military weight carrying machines will undoubtedly become available after the war. The importance the future aerial inter-city lines may have in the economic progress of Lybia may best be gaged by the fact that the shifting sands of that colony make the construction of railroads a very expensive and hazardous undertaking. The establishment of postal and passenger airplane routes would thus furnish a promising solution of the great difficulties under which public transportation labors in Northern Africa.

Signor Gianni Caproni's Views

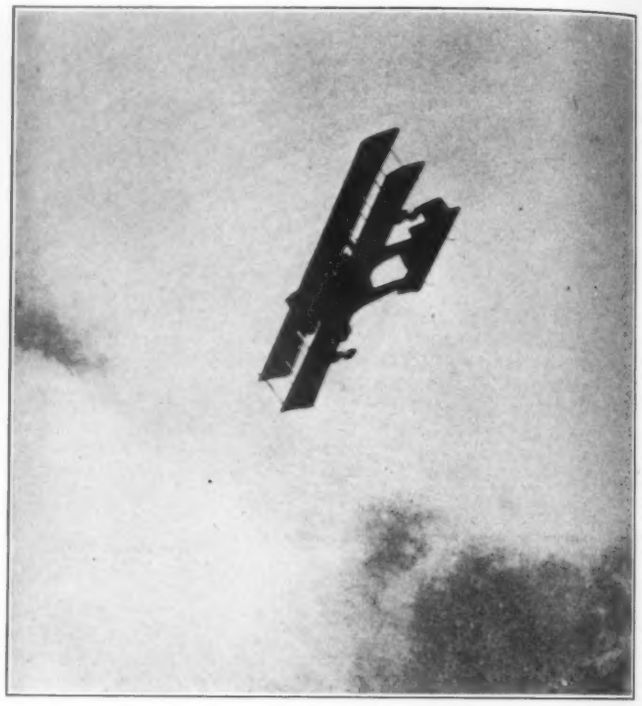
Such being Italy's official attitude in the matter of commercial aviation, it seems interesting to hear Signor Gianni Caproni, the well known constructor of large multiple engined airplanes, state his views on this subject. In an interview

granted to the aforenamed magazine Signor Caproni expressed himself as follows:

"Aviation, which has become such a decisive factor in the world war, is bound to exercise in the near future a considerable influence upon the economic fabric of every country; one so important, indeed, that a nation's very future might well hinge upon the development of this novel means of locomotion and transport. Up to now the mastery of the world belonged to him who possessed the mastery of the sea; but it may ere long become the property of him who will hold the mastery of the air.

"To achieve this object, a contest of aerial construction already is manifest among the major nations of the world. And in this race Italy seems to be predestined to become the mistress of the air. In fact, no other country in Europe finds itself so favored by geographic and atmospheric conditions as Italy for its future role of forming the stepping-stone of the air routes which will eventually lead from Northern Europe to the Mediterranean Sea and to Africa and Asia.

CAPRONI BIPLANE DIVING
(C) *Committee on Public Information*



THE SAME MACHINE BANKING
(C) *Committee on Public Information*

"Italian aviation has, in the opinion of experts, a considerable lead over the rest of the world in large, weight-carrying machines of a type which is particularly adapted to the transport of passengers and goods between Europe and her colonies, as well as between continents. To cite an example of the potentiality of these machines, I may be permitted to recall that not so long ago Gabriele D'Annunzio made a 1400-km. non-stop flight over the principal cities of Italy in an airplane which carried three passengers besides himself. As may be seen, the instrument wherewith to achieve supremacy in commercial aviation is readily available; it then only remains for us to possess the necessary spirit of enterprise and tenacity which is needed for putting all these conditions to a use favorable to our attaining the mastery of aerial trade.

The coming advent of commercial aviation does not, however, mean that aerial transport machines will take the place of railroads and steamships, or will at once enter into competition with land and sea-borne craft. This will require a certain time. It is, nevertheless, comforting to note how immense have been the strides which aviation has made in so short a time if one compares the brief and rapid evolution of the airplane with the time which elapsed between Fulton's experiments and the advent of the first cargo boats. This great speeding-up of progress is mainly due to a greater perfection of technical means and a higher development of science. The first steamboats had hardly space enough to carry the crew and the coal needed for short voyages, and decades passed before sailing vessels began to feel in earnest the competition of large steamships.

"In view of this parallel, it is interesting to note that the airplane is already capable of taking the place of other means of locomotion in certain regions and under certain circumstances, and with manifest advantages. It would be ludicrous to organize an aerial transport service in regions where railroad trains cover considerable distances in a few hours and under any atmospheric conditions. To be of any practical use, a public service must offer the advantages of convenience and regularity. In the Northern countries of Europe, for instance, where heavy fogs are frequent during long periods of the year, one cannot expect to run an aerial transport service with any hope of success as long as the problem of air navigation in fog is not solved. A step in this direction has already been made by the use of radio-goniometrics, that is, the determining of an aircraft's position from two land stations by radio telegraphy.

"A further difficulty which is at present likely to hamper the development of commercial aviation is the considerable cost the installation of an aerial transport service involves. All these difficulties would seem to indicate that it is somewhat premature to think of establishing commercial air lines at the present time. Nevertheless, there exist a number of cases where atmospheric conditions permit one to expect the running of air lines with a justifiable hope of regularity. Such may be considered the air lines which will eventually start from and converge in Italy, which country, thanks to its excellent geographical position, is likely to become an important center of aerial traffic. Such air lines seem particularly promising in cases where land and sea-borne traffic has to follow long, circuitous routes, because in this case the higher cost of aerial transit will be compensated for by the greatly shortened duration of the voyage.

"The most important and immediately practicable aerial service appears to be that devoted to the carrying of mails between the mother country and her colonies. To cite an example, at present it takes Italian mail steamers fifteen days to go from Genoa to Massaua (Eritrea), while a Caproni triplane could cover the same distance with mails and twenty passengers in less than two days, allowance of time being made in this estimate for the stops provided at the principal ports of call for the exchange of mails, the landing and receiving of passengers, etc. In the colonies, too, the large airplane may ere long become a valuable means of transit because of the few railway lines available and the immense loss of time incurred by caravan travel."

Standards of Construction, Fire Hazard and Fire Protection for Hangars

The following standards and recommendations have been prepared and are presented by the Queen Insurance Co. of America to indicate a general outline of good practice in well recognized fire prevention methods. They contemplate the hangar and shop equipment of a modern flying field, but it will be noted that they may be applied with equally good effect in the construction and equipment of a private hangar so far as the needs of the private owner may extend.

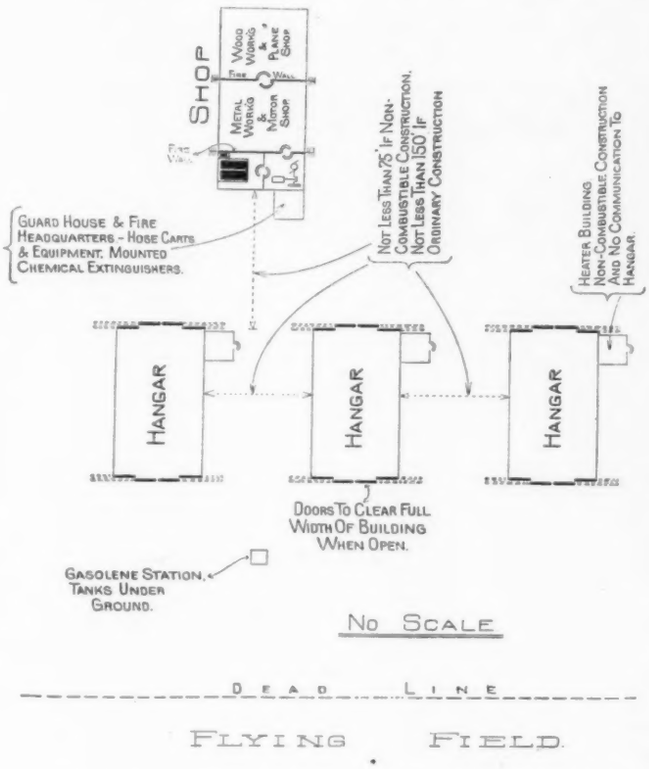
Construction

Walls: Structural steel framing, panelled with metal lath, or expanded metal, and cement plaster, or other type of non-combustible materials, and finished with similar non-combustible sheathing and air space where climatic conditions require reliable economical heating.

Roof: Structural steel trusses with steel purlins and panelled with approved asbestos slab or other approved fire resistive roofing. Trusses should not be less than 25 feet minimum height above floor.

Windows and Skylights should be of metal frame and sash and screened with small mesh heavy gauge wire, or preferably, glazed with wire glass.

Doors: Main doors should be located in that side of hangar not facing neighboring buildings and should be of "quarter door" overlapping sliding type with extension rails beyond each side of hangar so as to permit clear opening the full width of the building. Doors should be of non-combustible material, such as angle iron frame with corrugated steel covering. Such doors might well be installed also at rear end of hangar, not only to give easy access to Repair Shop desirably so located, but also to increase the facility with which machines may be removed in the event of fire.


SHOP
WOOD WORKING & PLANE SHOP
FIRE WALL
METAL WORKING & MOTOR SHOP
FIRE WALL
GUARD HOUSE & FIRE HEADQUARTERS - HOSE CARTS & EQUIPMENT. MOUNTED CHEMICAL EXTINGUISHERS.
NOT LESS THAN 75' IF NON-COMBUSTIBLE CONSTRUCTION. NOT LESS THAN 150' IF ORDINARY CONSTRUCTION
HEATER BUILDING NON-COMBUSTIBLE CONSTRUCTION AND NO COMMUNICATION TO HANGAR
HANGAR
HANGAR
HANGAR
DOORS TO CLEAR FULL WIDTH OF BUILDING WHEN OPEN.
GASOLENE STATION. TANKS UNDER GROUND.
NO SCALE
DEAD LINE
FLYING FIELD

Floor: Concrete on earth.

General: It will be noted that the foregoing standards aim to secure non-combustible construction. The further object of fire resistive construction is, of course, desirable. Either type, however, will minimize the seriousness of fire hazards within or without, for the protection of the machines themselves. At the occasional sacrifice of some facility in construction, non-combustible materials can always be used in place of convenient combustible substitutes.

Spacing of Buildings

Without adequate outside fire protection buildings, especially hangars, should be separated not less than 75 feet if of non-combustible construction, and not less than 150 feet if of combustible roof or wall construction. If there is good outside fire protection these distances may be reduced, say, one-third. This spacing may seem excessive, but it is deemed highly desirable in order to reduce the exposure to which the combustible surfaces of airplanes would be subjected when being removed to safety from a hangar of ordinary construction in the event of fire in a neighboring building; or, in the case of non-combustible construction, to prevent congestion of machines in front of hangars too close together. Attention is called to the importance of distributing machines among the several hangars of a group so as to avoid congested housing of costly machines subject to a single fire.

Fire Hazards

Heating: Steam, hot water or hot air. Source of heat should invariably be installed outside of hangar itself without direct communication therewith, thus avoiding introduction of kindling and fuel materials and the handling of ashes in the hangar. Chimneys should be built from solid foundations on the ground and of brick construction with tile flue linings. Combustible roof materials or supports should not enter walls of chimneys.

Lighting: Incandescent electric installed in strict conformity with the National Electric Code with which all competent contractors are familiar.

Repair Work: Should be done in separate building provided for that purpose. The repair shop should be of approved non-combustible construction, and preferably subdivided by a properly parapetted fire wall so that woodworking and plane shop may be separated from the metal working and motor shop. The power plant should be located in a separate section cut off by fire walls. The openings in fire walls should be protected by standard fire doors properly installed. All refuse, handling of volatiles and other fire hazards of shop work should be safeguarded in accordance with standard practice, details of which are numerous but well standardized. Further information along these lines will be furnished in accordance with individual needs.

In General: It is recognized that a certain amount of adjustment and similar work in hangars is probably inevitable, but this should be minimized and standard waste cans provided and their use enforced. All-metal ventilated lockers should be provided for clothing. Use of gasoline in blow torches or similar devices should be probibited in hangar. Cleaning of motors in a hangar or other work inviting the open use of gasoline should be discouraged. This sort of work should be done in repair shop or preferably in the open if possible. If gasoline is allowed to remain in airplane tanks when brought into hangar, the draining or filling of tanks in the hangar should be forbidden. The fire hazard of flooding the carbureter when priming an engine preparatory to flight is considered to be often serious; and it is therefore urged that a machine be removed to an unquestionably safe distance from hangar and other machines before the engine is primed or started. In conformity with good practice, machines should not be allowed to approach closer than 150 feet to a hangar under power.

Gasoline Supply should be kept in underground tank not less than fifty feet from nearest building, and equipped with approved pump and a minimum working length of hose. Reservoirs of planes should be filled only at the outside gasoline station, and by hose.

Fire Protection

Not less than one approved chemical extinguisher of the carbon-tetrachloride type and six standard fire pails should be provided for each 2500 square feet of floor area or fraction thereof, also fire axes and pike poles; all distributed to best advantage, and their locations conspicuously marked. If reliable, adequate, organized outside hydrant and hose protection is not available, a suitable number of hand-drawn, mounted chemical units should be provided.

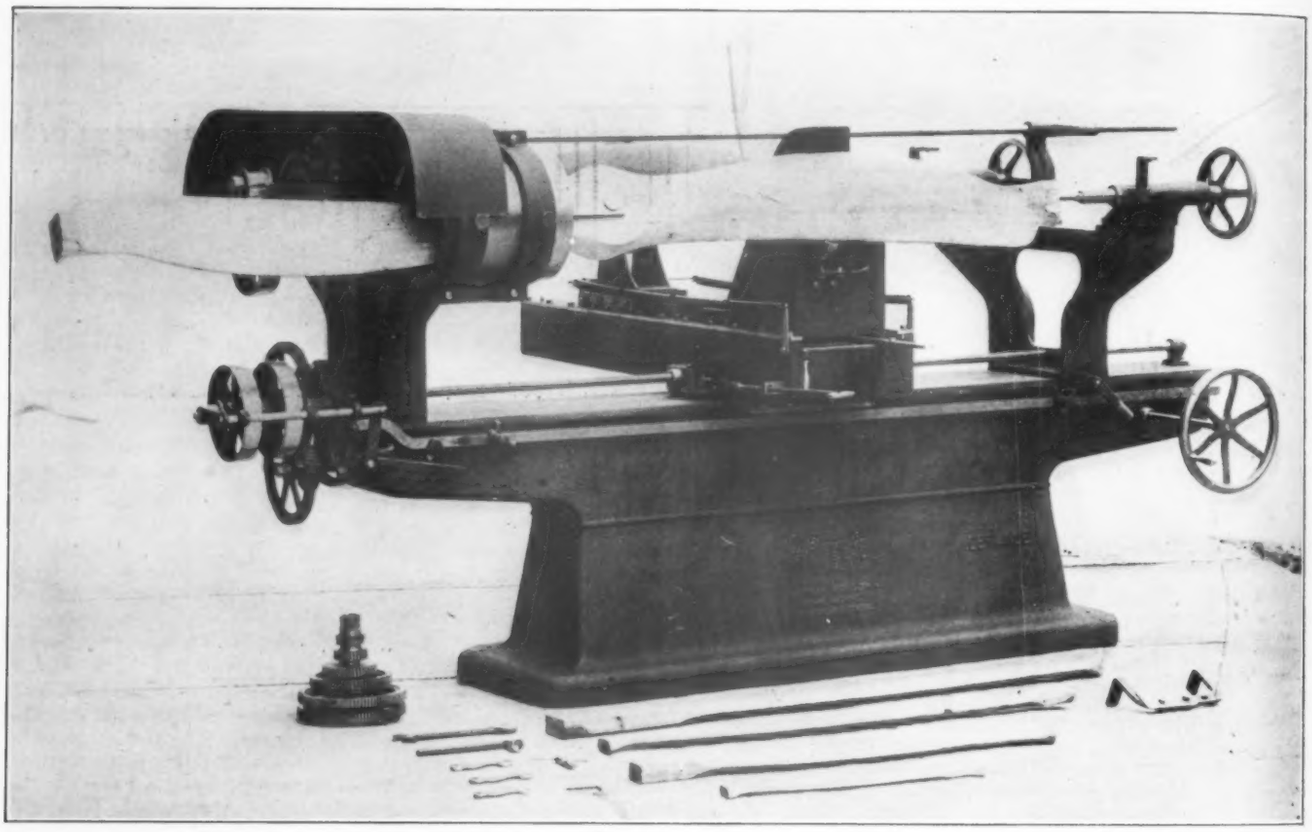
Watchman: Watchman or guard service should be provided covering all portions of the premises. Any special heating necessary for watchmen or guards should be properly installed

in a guard house and not in a hangar or other building of importance.

The Queen Insurance Co. of America, 84 William Street, New York, will welcome opportunities to advise with airplane manufacturers or users or others interested in such building projects, or their architects, on the application of the foregoing or any other fire prevention or fire protection standards and practice.

An Airplane Propeller Turning Lathe

An airplane propeller turning lathe has been designed by the Defiance Machine Works for the turning of propellers and struts, as used on the various types of aircraft, but it can also be used for the production of other irregular shaped articles of varying lengths and widths up to 12 in. in width or diameter by 10 ft. 4 in. in length. This machine is one of the latest adaptations of a copying lathe and will produce exact facsimiles of the models used, producing both right and left hand pieces from the same model, and by a simple, quick adjustment of the tail stock, either end of the work or the entire piece can be made larger or smaller than the model.



THE DEFIANCE PROPELLER TURNING LATHE

The feeding machanism which controls the cutter-head carriage is arranged to feed from right to left or from left to right alternately, or it may be adjusted to feed in one direction only. The starting station may be at the right or left hand end of the machine as desired. It has five changes of feed from 1/8 to 3/8 in. varying 1/16 in. to each revolution of the work being turned and it can be started or stopped instantly at any position of the cut. At the slowest rate of feed it will turn 2½ in. per minute and at the fastest rate 13 in. per minute. Adjustable stops are provided for automatically regulating the length of travel to the cutter-head which can be instantly set for any length of turning within the range of the machine.

The cutter-head is fitted with six right and six left hand knives to feed both ways and will turn successfully either hard or soft wood. It is mounted upon a sliding frame and supported by a substantial carriage which travels across the path of the material to be turned by means of a heavy feed screw driven by double friction pulleys operated by a convenient hand lever for starting the feed which is automatically disengaged when the end of the cut is reached. The frame supporting the cutter-head and guide roller is gibbed to the carriage and vibrates in a path to correspond with the shape of the model placed into the machine and is connected with a convenient hand lever to bring the cutter-head up to the work or throw it back out of the way which can be accomplished while the machine is in motion.

A hollow chuck is used when turning propellers on this machine, as each blade of the propeller is turned separately. The propeller is clamped in this chuck by means of a pin which is inserted through the hub, holding it securely and centering it accurately. This chuck is also used when turning struts that measure over 5 ft. in length.

A centering device can be furnished when so ordered for centering the stock before being placed into the machine. By this method smaller stock in the rough can be used which effects a larger saving in material. This device locates the center marks quickly and accurately.

The machine, as regularly furnished, is supplied with one steel cutter-head complete with knives, one governing model, counter complete and the neecssary oil cups and wrenches.

The counter is furnished as follows: shaft 2 3/16 in. x 13 ft. long; three No. 3 roller bearing drop hangers, fitted with rack and pinion belt shifting apparatus; one two-step cone pulley 4 and 6 in. diameter by 2⅛ in. face; one drum for driving cutter-head 16 x 77 in., made up of 7 pulleys 16 in. diameter by 11 in. face; two feed pulleys 5 x 2 in. and 3 x 2 in.; tight and loose pulleys, 12 x 4 in., with the loose pulley fitted with sectional bronze bearings; speed 420 r.p.m.

This lathe occupies a floor space of 68 x 120 in., weighs 3580 lb., and takes 6 hp. to drive, a 7 hp. electric motor being suggested as the proper power installation.

The Cleveland Aero Engine

Considerable attention has been directed lately to an aeronautical engine which is a decided departure from the usual design, and which has many novel and interesting features. This particular engine is the Cleveland aero motor designed by Walter C. Willard.

In this engine parts are so standardized that the same parts, with few exceptions, may be used in the assembly and repair of any size engine from 100 to 600 hp. and, as the design is very simple, the engines may be produced with sufficient accuracy under forced production.

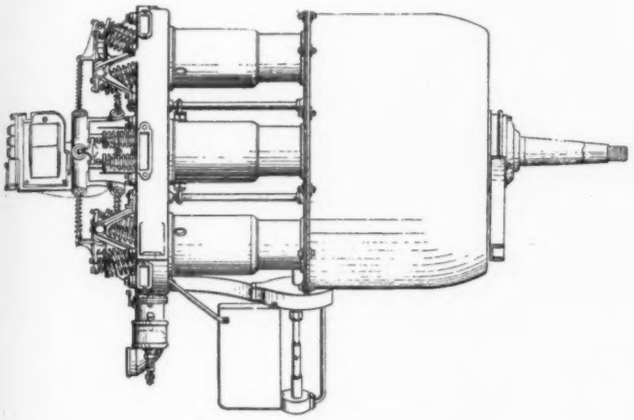


FIG. 1. SIDE ELEVATION

Figs. 1, 2, 3 and 4 show the Model 4 150 hp. This model has six cylinders (5 in. by 6 in.), arranged with their axes parallel to the drive shaft. This is known as the "barrel" type of motor, and with this type head resistance is reduced to a minimum. Each cylinder transmits its power to a single throw crankshaft. Each crankshaft has a bevel gear, which meshes with a large "bull gear" on the main drive or propeller shaft. The propeller shaft turns at half the speed of the crankshafts. In this way high piston speed is obtained, and at the same time an efficient propeller speed. Also as the drive shaft turns at half the crankshaft speed, the cams operating the valves may be mounted directly on the drive shaft.

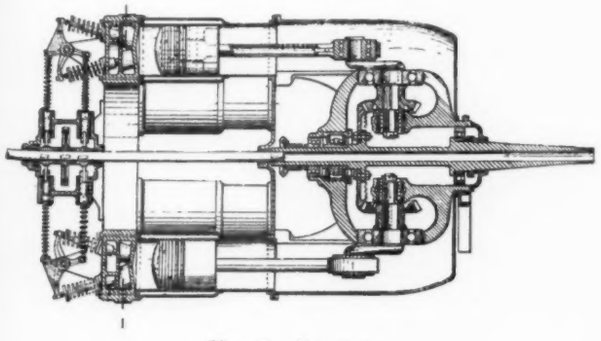


FIG. 2. SECTION

The engine is of the four-stroke cycle type, explosions occuring regularly in sequence around the ring of cylinders. There is a power impulse on the propeller shaft every 60 deg. of rotation. All-ball-bearing construction is used, and in this way much lubricating mechanism is done away with and weight is saved. Considerable weight is also saved in doing away with a crankcase casting; only a light sheet metal case being required.

Cylinders

The cylinders are designed and supported in such a way as to minimize the stresses due to changes in the temperature. Strains due to combustion at the piston head are taken up by a pair of steel alloy studs so placed that each main bearing is hung in a sort of U-shaped saddle, the studs passing clear through the cylinder heads.

Valves

Two intake and two exhaust valves are provided for each cylinder. One cam is used for all the intake valves, and one cam operates all the exhaust valves. Each valve is independently adjustable for clearance. The valves are interchangeable, and each pair of valves is operated through a single bell crank and push rod.

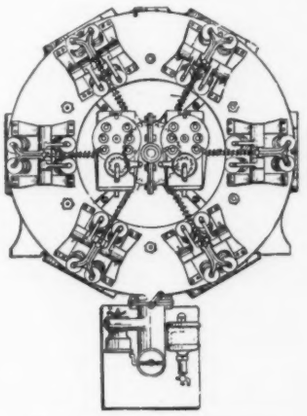


FIG. 3. END ELEVATION

Cooling System

The engine is water-cooled. The gas intake manifold and the water intake and outlet are all incorporated in a single casting forming the cylinder heads. Water is circulated by a pump.

Lubrication

All the lubrication required is secured by the running of oil on the "bull gear." This gear throws the oil about to properly lubricate other parts. The excess oil is pumped from the oil case and used over again.

Ignition

The ignition system is so arranged that either two magnetos, a magneto and a battery, or two batteries may be used. The plugs are located so as to have complete combustion take place in the shortest time possible. The plugs are so placed that there is no danger of their coming in contact with any oil which might possibly accumulate. The plug bosses are completely surrounded with an ample supply of water.

Starting

The engine may be started by cranking from the machine, by cranking at the propeller end, or the engine may be fitted with any type of self-starter. The mounting of the engine is of the three-point type.

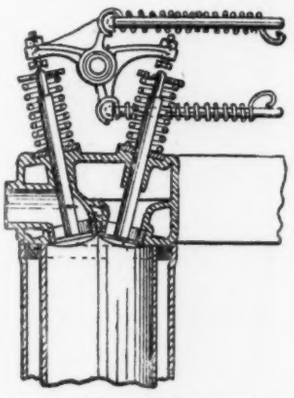


FIG. 4. VALVE MECHANISM

Materials

Materials have been chosen for this engine which offer strength and endurance qualities, and each alloy is chosen so as to be fitted for the particular work required of it.

The crankshafts are forgings of chrome-nickel steel, carbonized and heat treated. The connecting rods are of the same material, although differently heat treated. The "bull gear" and drive pinions are also of chrome-nickel steel so carbonized and heat treated as to give long life. These gears are non-adjustable for pitch line mesh. The main drive shaft is from the same steel alloy. The bearing supports are of manganese bronze. The cylinders are of 30-40 point carbon steel tubing, with the jackets and the plug bosses welded to the steel tube. The combination cylinder head and manifold are an aluminum casting. The pistons are of aluminum alloy, and have three rings each. The valve seats are of phosphor bronze and are easily replaced.

New Balloon Fabric Patented

A new process balloon fabric has been developed by John R. Gammeter of Akron, Ohio, and a patent has been applied for. The new fabric consists of rubberized, interwoven parallel threads of cotton, linen or silk, the whole being attached to a thin sheet of pure gum to keep the threads in a band while weaving, when they are passed through a rubber cement.

The Y. M. C. A. School for Air Mechanics

The insistently recurring demands of the Army Air Service for aircraft engine mechanics emphasize the necessity and importance of building up an organization of men capable of taking efficient care of our military and commercial airplanes. To fill this need the West Side Y. M. C. A. of New York City opened some time ago a school for air mechanics where pros-

STUDENT STARTING ENGINE ON TEST BLOCK

pective applicants to Army service are given a thorough course in the care and repair of aircraft engines.

Because of the increasingly large number of men who are daily applying for this instruction the West Side Y. M. C. A. has been compelled to recently increase the capacity of its school for air mechanics. In order to give each student the benefit of demonstration *de visu*, the Y. M. C. A. has acquired from another school, which went out of business, a Gnome engine and three other aircraft engines of diverse types. A number of parts have also been purchased. This matériel is

LEARNING THE CONSTRUCTION OF AN AIRPLANE

being used with the one already on hand in the courses of plane and engine assembly and repair.

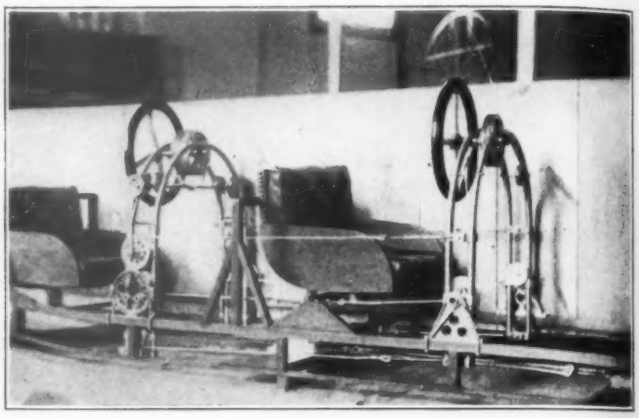
As a result of its work the school recently received a letter from the United States Public Service Reserve in which it was suggested to send any eligibles to join the service and thus help in the drive this organization is making for getting 4,000 motor mechanics for the Army. In reply several graduates of the air mechanical school joined the service.

In referring to the benefit of the school to the individual and to its constant growth, the management says:

"A mechanical genius who had sacrificed his bent to a low-salary job as bookkeeper, heard of the call for men to do their bit keeping airplanes in repair, went through the school and is employed at three times the salary in an airplane factory at Plainfield, N. J.; he could not pass the Army physical test. The enrollment always is far ahead of the capacity."

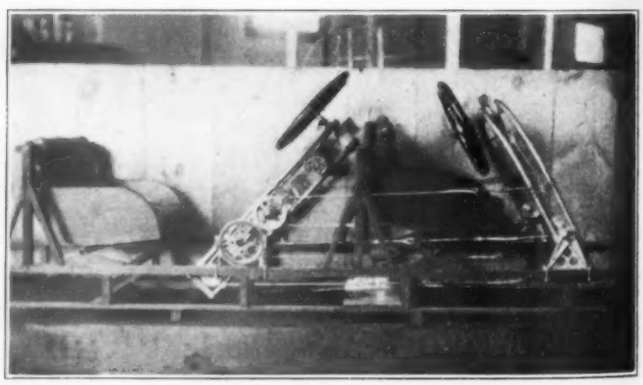
A New Safety Dual Control

A new safety dual control of the Dep type has been brought out by the Michigan Aircraft Co. of Grand Rapids, Mich. The advantage of this new type is that it provides a complete release of the student's control system, while the wires leading from the instructor's yoke and rudder bar are positively connected to the control surfaces, in compliance with standard practice, and are not affected by the operation of the student cut-out device.



STUDENT'S CONTROL CONNECTED

The wires from the student's aileron wheel run to a pulley on the instructor's control. This pulley is mounted on a sleeve which is ordinarily connected with the main aileron control by a tooth clutch. A turn of the cut-out wheel (located on the further side of the yoke and on a level with the bottom of the hand wheel, in the photographs) disengages the clutch and the student's control. The elevator wires from the front, or student's seat run over pulleys on the side of the instructor's yoke, a similar clutch being fitted. The rudder bars are inter-connected through sprockets, strong block chains, and cables, the student's control system being again fitted with a clutch which allows it to be released at will by the instructor. These clutches are all operated by the single cut-out wheel mentioned above.



STUDENT'S CONTROL RELEASED

The whole system is relatively simple and is positive in operation, while at the same time it in no way interferes with the direct operation of the controls by the instructor.

Aircraft Inventions Wanted

The National Advisory Committee for Aeronautics has issued the following:

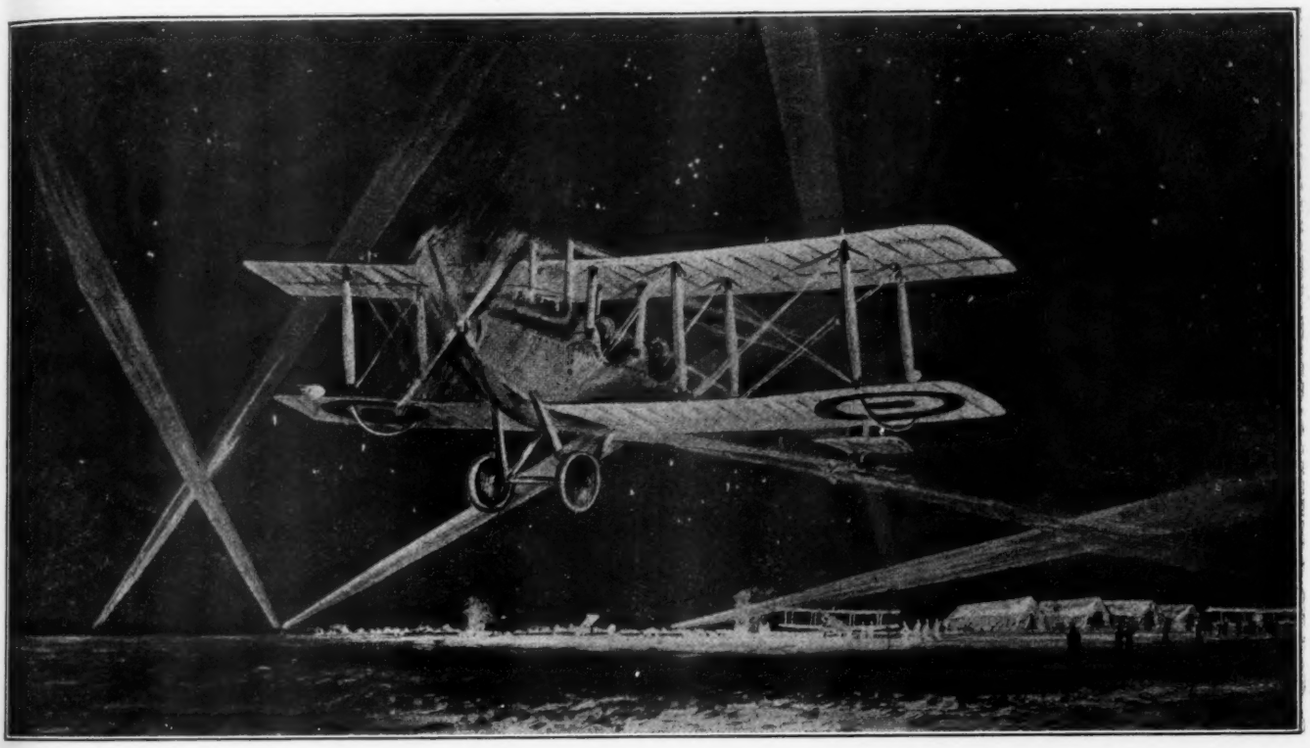
All parties desiring to bring to the attention of the Government inventions pertaining to aeronautics, or suggestions for improvements of existing types of aircraft and their appurtenances, are requested to communicate with the National Advisory Committee for Aeronautics, Munsey Building, Washington, D. C., and to submit comprehensive outlines of the proposed devices, together with necessary drawings, data, and the results of tests, if tests have been made.

Digest of the Foreign Aeronautical Press

***Aeronautics*, January 2, 1918**

Aircraft Engines at High Altitudes.—Whatever types of engine may eventually predominate among military and naval aircraft, there is at least one respect in which they will differ very widely from those used for the propulsion of commercial airplanes—namely, the height at which maximum power will be available. The power developed by an ordinary engine of fixed compression ratio becomes less as the height of the machine above sea level increases, the fall in power being roughly proportional to the fall in density of the atmosphere. This reduction of power is due to two causes—firstly, because the pressure of the atmosphere becomes less as higher altitudes are attained, and, the compression ratio being constant, it follows that the compression pressures and consequently the explosion pressures are reduced accordingly; secondly, owing to the lower density of the air at great heights, the mass of the mixture drawn into the cylinders during one induction period is less than when the machine is on the ground, consequently the "heat value" of the charge is reduced. An ordinary engine running at a height of about 15,000 ft. develops little more than half its power output at sea level; fortunately the air-resistance (and the lift) diminishes as the height increases; but as the fall in resistance is not quite so rapid as the diminution of power, the speed and also the rate of climb deteriorate as the airplane climbs higher.

Now, if an engine could be constructed whose power output remained constant at all heights, present airplane performances could be tremendously improved; and it is along these lines that engine design is bound to proceed. On the surface the design of such engines may not appear to be attended by many difficulties—neither is it, up to a certain point. Several engines are already in existence which develop their maximum power at 10,000 ft., but nobody has yet brought forward a practicable scheme for maintaining constant power up to 20,000 or 30,000 ft. The system at present employed is to provide a combustion space so small that the compression ratio is from 6.5 to 1 to 7.5 to 1. At ground level the use of so high a compression for any length of time would be impossible, consequently at very low altitudes these engines are kept well throttled down, and only fully opened out at about 10,000 or 12,000 ft., when the compression pressure is much the same as in the ordinary engine at ground level; of course, as the altitude increases these super-compression engines are subject to same rate of fall in power common to the ordinary type, but instead of this reduction commencing as soon as the machine leaves the ground, it does not commence until after an altitude of 10,000 ft., or thereabouts, has been attained. Obviously there is a distinct limit beyond which this "super-compression" cannot be carried, although it is difficult to say what this limit precisely is; for instance, if it were required to maintain at 20,000 ft. a compression pressure corresponding to that obtained by a ratio of 5 to 1 on the ground, then a ratio of more than 9 to 1 would be necessary. Moreover, this arrangement is fraught with considerable risk, for in the event of the pilot inadvertently opening the engine "all out" while on the ground, extensive damage to the engine would inevitably result.



A British Night Flying Machine for Anti-Airship Defense
Courtesy of Flight

What is really wanted is some practicable scheme of forced induction and variable compression, so that the mass of the charge and the pressure to which it is compressed remain constant under all atmospheric conditions. In designing an engine to operate at very high altitudes many difficult problems are encountered in connection with carburation, owing to the extremely low temperatures obtaining. Machines capable of flying at 40,000 ft. will doubtless make their appearance in due course, but in such machines the ordinary carburation arrangements would be futile. Some form of direct injection will be essential, and unless special means be provided it is highly probable that the petrol tanks themselves will freeze. It is by no means impossible that in future machines intended to fly at these prodigious heights the petrol will be vaporized in a boiler preparatory to entering the cylinders.

***Espana Automovil* (Madrid), December 15, 1917**

A Visit to the Döberitz Aviation Field.—Captain von Pustau, of the German navy, describes in the Deutsche Warte a visit he recently made to Döberitz, Germany's principal aviation center. Speaking of the artillery airplanes, von Pustau declares that the Geber model is fitted with a radio apparatus which has an effective radius of 50 km. and weighs only 30 kg. complete. The problem of receiving radio messages on airplanes has been satisfactorily solved by increas-

ing the intensity of the sound waves. For high altitude flying electrically heated machines are now available.

In regard to the armament of the German airplanes bombs varying in weight from 4.5 kg. to 300 kg. are carried by the bombardment machines; for the use of battle airplanes a 2 cm. quickfiring gun has been developed, which is synchronized with the engine and fires through the blades of the airscrew.

Flight (London), January 10, 1918

On the Schütte-Lanz Airship.—Incidental to the conferring of an honorary degree upon Prof. Schütte, the inventor of the Schütte-Lanz wooden frame airship, it has just been made public in Berlin that a Schütte-Lanz some time ago accomplished the longest airship cruise on record—Germany to Constantinople. The paragraph issued semi-officially says that regarding the technical developments which have taken place in the construction of S. L. airships during the war nothing has reached the public for military reasons. It is said to be an open secret, however, that these vessels have been associated in very eminent degree with German aerial operations on land and sea

Flying (London), January 9, 1918

The Italian SV 200 Hp. Fighter.—The "SV" (which stands for Savoia-Verduzio) is a single seater tractor biplane. Struts are of steel tubing, inclined so as to do away with the wiring, which is usually employed to take care of the lift and landing strains on the wings. The incident wiring conforms to the customary practice. In aggressive aerial tactics its speed and armament are the principal features of its formidability. A speed of 139 m.p.h. is claimed for the "SV" when flying near the ground. Two Vickers machine guns are arranged to fire through the propeller.

The upper plane has a span of 30 ft. 3 1/16 in.; overall length, 29 ft. 5/8 in.; overall height, 9 ft. 1 in. Area of the lifting surface, 261 sq. ft. Weight of the machine empty, 1,267 lb.; gross weight, 1,763 lb. In the gross weight a military load of 495 lb. is distributed as follows: Fuel and oil sufficient for an air endurance of 2½ hours, 220 lb.; pilot, 176 lb.; the two Vickers machine-guns, 99 lb. The loading of the machine is 7.2 lb. per sq. ft. of surface and 10.1 lb. per b.hp.

In 1 min. and 40 sec. the "SV" can climb to 3250 ft.; 4 min. 30 sec., 6500 ft.; 8 min., 10,000 ft.; 12 min. and 50 sec., 13,000 ft.

The SPA-6A engine, which is installed in the "SV" is a 6-cylinder water-cooled engine having a nominal horsepower of 100, and which shows a normal horsepower on a bench-test of 220 at 1600 r.p.m Bore and stroke, 5.31 by 6.69 in. Overall dimensions of the SPA engine: length, 5 ft. 1 1/16 in.; height, 3 ft. 3 1/16 in.; width, 1 ft. 6 1/8 in.

Weight of the engine complete, dry, 564.22 lb.; weight per brake horsepower, 2.55 lb. Two Zenith carburetters and two Type N2 Marelli magnetos are used. Gasoline is consumed at the rate of 99.4 lb. per hour; 7.6 ounces per brake horsepower. Lubricating oil is consumed at the rate of 7.05 lb. per hour; 0.53 ounces per brake horsepower.

The Aeroplane (London), January 8, 1918

British Aerial Medical Service Proposed.—Discussing the unification of the British Air Services and the creation of the Air Council, the *British Medical Journal* says:—

"The Order contains no reference to an Air Medical Service, but it is clear that such a service must at once be established, and it is sincerely to be hoped that the vacant seat on the Air Council may be filled by its Director-General. Part of the work of the Air Medical Service will be of the ordinary kind which falls to be performed by every military medical service, but much of it will be conditioned by the peculiar duties of an air force.

"A man who aspires to fly must be submitted to very strict physical examination by the Air Service medical officer before he is sent to be trained; he must be very carefully watched during his training to discover any latent weakness, and after he has been passed as a flier constant supervision must be kept over the state of his general health, and especially over the condition of his nervous system, to insure that the perfect adjustment between senses, brain, and muscles, which he must have possessed when he passed the flying tests, is maintained.

"Civil practitioners have hitherto had nothing to do with air problms, and physiologists very little. It is therefore incumbent on the Secretary of State for the Air to institute and encourage research into the special physiological and medical problems awaiting solution for the greater efficiency of his service and the saving of lives and equipment."

Flight (London), January 17, 1918

An Australian Record Flight.—Some very fine performances were put up in Australia in November last by Lieut. W. J. Stutt, a pilot of the State Aviation School. On his Curtiss biplane, he flew from the Richmond school near Sydney, N.S.W., to Point Cook near Melbourne, Victoria, covering the journey of 600 m. in 9 hr. 32 min., his best non-stop being 263 m. in 3 hr. 37 min. He improved on this considerably on the return journey, for which his total time was 7 hr. 20 min. He had one stop of 1 hr. 17 min. at Cootamundra—and his best non-stop run was 342 m. in 4 hr. 10 min., averaging 82 m.p.h. This is a record for Australia. Lieutenant Stutt is the first aviator to fly between Melbourne and Sydney in one day. During the return journey he encountered very bad weather, and after passing Goulburn was driven out to sea by a rainstorm. A passenger was carried during the first part of the journey, but Lieutenant Stutt flew alone for the concluding stage, as the engine was not running at its best. Point Cook was left at 5.53 a. m., Cootamundra reached at 10.30 a. m., and left at 11.20 a. m., the machine finally landing at Richmond at 2.30 p. m.

Flying (London), January 16, 1918

German Aero-Engines.—The three principal German makes of aero engines are each represented by two different sizes, the Benz engines being of 160 h.p. and 220 h.p., the Mercédès 160 h.p. and 260 h.p., and the Argus 120 h.p. and 200 h.p. On only the last-named engine has there been much attention given to elaborate finish, and the other two makes give evidence of a great deal of discretion in the question of finish as well as in simplicity of detail. The Argus engine is the only one which has its cylinders arranged in pairs with one sheet iron water-jacket enclosing the two cylinders, and on the whole the design of this engine does not seem to be equal to that of the others.

The progress made in the design of these engines during the war is perhaps best indicated by that of the Benz engine, one of which secured premier place in the German aero engine trials of 1913, and the present-day engine shows that a weight reduction of about one-third has been obtained, and even after this saving of weight has been effected the engine gives a better performance than the pre-war model.

The following performances were found possible with a L.V.G. machine fitted with a 160 h.p. Benz engine and a D.F.W. Aviatik machine fitted with the larger size of Benz engine:—

Engine, 160 h.p. Benz.
Number of crew, two.
Span, 42 ft.; length, 27 ft.; height, 10 ft.
Total weight fully loaded, 2140 lb.
Air duration, 4 hr.
Speed at 9000 ft., 65 m.p.h. Revolutions per min., 1355.
Speed at 10,250 ft., 60 m.p.h. Revolutions per min., 1345.
Climb to 5000 ft., 15 min. 20 sec. Revolutions per min., 1360.
Climb to 10,000 ft., 48 min. Revolutions per min., 1330.

Engine, 220 h.p. Benz.
Number of crew, two.
Total military load, 545 lb.
Speed at 6500 ft., 96 m.p.h. Revolutions per min., 1415.
Speed at 10,000 ft., 94½ m.p.h. Revolutions per min., 1390.
Climb to 6500 ft., 11 min. Revolutions per min., 1340.
Climb to 10,000 ft., 20 min. 8 sec.
Revolutions per min., 1330.
Air duration, about 3½ hr. at full speed at 10,000 ft., including climb to 10,000 ft.
Approximate ceiling, 17,000 ft.
Total weight fully loaded, 3245 lb.
Total military load as follows: Pilot, 180 lb.; passenger, 180 lb.; Spandau gun and ammunition, 65 lb.; Parabellum gun, 46 lb.; deadweight, 74 lb.; total, 545 lb.
Span, 43 ft. 6 in.; length, 25 ft. 10½ in.; height, 11 ft.
Surface of main planes, 455 sq. ft.
Weight per sq. ft., 7.1 lb.
Weight, fully loaded, per horsepower, 16.3 lb.

News of the Fortnight

Aviators' Special Pay to be Discontinued

It is announced from Washington that following the receipt of a cablegram from General Pershing the War Department has been led to consider the discontinuance of aviators' special pay. The matter has not, however, definitely been decided upon as yet.

General Pershing's cablegram is as follows:

"For the reason that flying duty in the Air Service is no more hazardous than duty with combat troops and involves nothing like the hardships endured by troops which occupy trenches, repeal is recommended as early as possible of laws providing increased rank and pay for qualifications as junior military aviators, military aviators, junior military aeronauts, military aeronauts, and for any other increased pay for engaging in aerial flights.

"Such laws are productive of improper balance in rank and pay and result in injustice to other men and are no longer necessary in order to get personnel as was the case when passed and aviation was in experimental stage. Gen. Foulois is in full accord with the recommendation."

Acting upon the recommendation Secretary Baker has submitted the text of a bill to the Senate Committee on Military Affairs for introduction in that body at an early date. It will apply to both present and future aviators and cadet aviators. At this writing it had not been printed, but it is understood that it will create another grade of aviator, to be filled by especially qualified civilians and that the pay for same will be $150 per month.

Annual Report, U. S. Coast Guard

The annual report of Capt. E. P. Bertholf, Commandant of the U. S. Coast Guard, contains the following reference to coast guard aviation:

"Development of the project for utilizing aviation in the work of saving life and property has been suspended during the past fiscal year, except in the matter of training personnel. The authority of Congress was obtained for the establishment, equipment and maintenance of ten aviation stations for the Coast Guard and a school for special instruction in aeronautics also was authorized." At present the personnel of the service includes three commissioned officers qualified as "naval aviators," seven enlisted men qualified as "airmen" and one commissioned and two warrant officers serving as naval inspectors for the construction of aircraft. In addition, three commissioned officers are under instruction as "student naval aviators" and five enlisted men as student "airmen."

Army Orders Forbid Newspaper Work

A War Department order forbidding officers and men in the army to publish books on military instruction or tactics without first submitting them to the General Staff has just been amended to prohibit also persons in the military service from serving as correspondents for any newspapers or other publications.

The War Department adds, however, that no objection is held to the publication of a soldier's private correspondence, with his consent, providing the letters are sent through the regular censorship machinery. Military censors are at the same time ordered to delete "criticism of superiors or of policy, scandal of any sort, injurious reports concerning comrades or anything likely to arouse controversy."

The C. P. I. Airplane Service

Under the title, "The Activities of the Committee on Public Information" the first report of that organization has just been published. Under the heading "Airplane Service," it says:

"An increasingly important part of the work in foreign countries is concerned with the distribution of our printed matter by aircraft. Bombardment planes, loaded with leaflets and pamphlets that carry the truth to deluded peoples, go regularly over the firing lines and far into the lands both on the eastern and western fronts. The success of the campaign depends, as a matter of course, upon the number of planes that we are able to employ, and have made a request upon the War Department for such number of machines as will permit us to cooperate with the French in the formation of an escadrille."

Aircraft Manufacturers Are Exempt

Manufacturers of aircraft are exempt from the provisions of the order curtailing the use of fuel.

The purpose of the recent order of the United States Fuel Administration looking to conservation of fuel is to help, and not to delay, the manufacture and delivery of essential war material. This was made plain in a telegram from Harry A. Garfield, United States Fuel Administrator, to James J. Storrow, Federal fuel administrator for New England.

The telegram was as follows:

"The Burgess Company of Marblehead, Mass., manufacturers of airplanes, and expressly exempt from the order of Jan. 17, state they have been refused coal by order of your office on the basis of instructions from Washington. The obvious purpose of the recent order is to help and not to retard the manufacture and delivery of essential war material. Producers and vendors of food, manufacturers of ships, aircraft and explosives, and the firms and companies named in our telegrams and sent you by mail on Friday are to receive coal next after those mentioned in section one of the order of Jan. 17 and before all others."

French Air Board Created

Following close on the heels of the reorganization of the British Air Services comes the news of the creation of a French Air Board.

The new Air Board, called Superior Council of Aeronautics, has as its head the Minister of Munitions, who is assisted by the (civilian) Sub-Secretary of State for Aeronautics, one representative of General Headquarters and the heads of the various services concerned.

An aerial program will be drawn up from time to time at general army headquarters and submitted to the under-secretary for aviation, who in turn will lay it before the new air board. After a careful study of the program this board will decide the number of machines to be built and immediately award contracts for their construction.

Rating of Military Aviators

Recent regulations of the War Department provide for the rating of reserve military aviators as junior military aviators, and military aviators after a prescribed period of service or for distinguished service upon the recommendation of the commander in charge of the forces in the field.

According to the special regulations, officers of the Signal Reserve Corps and those temporarily commissioned in the Signal Corps, who have passed the reserve military aviator's test, will not be rated as junior military aviators until they have served satisfactorily for six months as reserve military aviators in the United States, or have served satisfactorily for three months as reserve aviators on active service in time of war, or four months at a training station and two on active war duty.

In time of war, however, a reserve military aviator who especially distinguishes himself in active service may, upon the recommendation of the commander in chief of the field forces, approved by the Chief Signal Officer, be rated as a junior military aviator or a full military aviator.

Aviation Accountants Wanted

Positions as expert accountants to handle several hundred millions of dollars worth of Government aviation purchases are open through the Civil Service Commission. Over 150 trained men must be secured at once, some of whom will be commissioned as reserve officers, while others will continue as civilians with salaries running from $2,400 to $6,000 a year. This is higher than any salary ever before attainable through Civil Service examination.

These men will form the second increment of an accounting force which already numbers more than 100, and which eventually will total more than 400.

Kershaw Manages Standard

It is reported that G. D. Kershaw, who until of late was vice-president of the Advance-Rumely Co., La Porte, Ind., has taken the position of manager of the Standard Aero Corp.

13,500 Aircraft Workers in N. Y. State

The first report of the survey of industries engaged in war work to ascertain the labor supply, has been made public by the United States Employment Service. The report covers the state of New York and shows that in the 500 factories visited 261,117 persons are employed and that about 176 of these factories are calling for additional labor. It also shows that the industries making the largest call for labor are those engaged in the manufacture of airplanes and seaplanes, which employ 13,474 persons, and ordnance and ammunition, which employ 9667 persons.

The report states that there has been a heavy decrease in war orders in certain lines, including the manufacture of airplanes.

Naval Aeronautical Draftsmen

During the present emergency and for the minimum length of time thereafter as may be rendered necessary by the needs of the service, the classified position of aeronautic draftsman under the Navy Department may be filled upon non-competitive examination.

This order is issued upon the recommendation of the Secretary of the Navy and the Chief of the Bureau of Construction and Repair, who state that on account of the difficulty experienced in inducing qualified men to accept positions subject to the present rules and methods of appointment, it is deemed impracticable now to fill these positions by open competitive examination.

Aircraft Board Opens Branch Office

Announcement is made by the Aircraft Board of the opening of a Pacific Coast branch office, with headquarters at Portland, Ore. George S. Long of Tacoma, Wash., lumberman, and Col. William M. Ladd, of the Signal Corps Aviation Section, and a Portland banker, both of whom were recommended by Brig.-Gen. Charles McK. Saltman, chief assistant to Gen. George O. Squier, Chief Signal Officer, compose the new board.

Army Aeronautical Appropriations

At the opening of the second of the Sixty-fifth Congress, the total sum of $1,126,654,260 was asked for the aeronautical program of the Army, the Navy, the National Advisory Committee for Aeronautics, and the Post Office Department. Of this amount, $1,032,294,260 was asked for the Aviation Section of the Signal Corps of the Army, which amount, at least, it is estimated, will be required to carry out the aviation activities of the Army branch of the service for the fiscal year ending June 30, 1919. This sum, which is nearly double the amount of $640,000,000, appropriated for the previous fiscal year, and all of which has been obligated, does not include the estimated requirements of $105,000,000 for the needs of the Signal Corps for the same period.

Production Division Moves to Cleveland

For the purpose of speeding up the aircraft program of the war the plane headquarters of the Production Division of the Aviation Section of the Signal Corps of the Army is being moved from 119 D Street, N. E., Washington, D. C., to Cleveland, Ohio.

The western office will be in the Union Building, where Major H. L. Shepler, Chief of the Production Division and about fifty inspectors will have offices.

Aircraft Factory in Ireland

Referring to the British Government's decision to erect an aircraft factory in Ireland, the *Times* says that several aerodromes are now being built there. The establishment of a new and important industry, it adds, is stimulating the national imagination, and there will be no lack of Irish recruits for the flying corps.

Anglo-French Air Mail

Plans for the establishment of an aerial postal service between France and England are rapidly approaching realization and it is now believed that such a service on a limited scale will be put into effect without waiting for the end of the war. It will be used for carrying official correspondence, especially that of the interallied committee sitting at Versailles. Reports and communications from the American representatives thus will catch the mail boats from England in about two days' better time than by the old methods.

The Eagle Aviation School

With an instruction staff headed by three aviation officers direct from the firing line, the Eagle Aviation School has been established at 114 West Forty-second Street, New York City, to teach all branches of aviation to students who wish to enter the United States air service or the airplane industry. The staff is headed by Lieut. W. Knox Denham, of the Royal Flying Corps, who has had two and one-half years' experience. He is assisted by Lieutenant Lynch and Lieutenant Jardine, both of the Royal Flying Corps, and both with two years of experience.

The school has leased a tract of land at Farmingdale, Long Island, which will be used for the training of students in actual flying. In its New York class rooms will be taught such subjects as engines, planes, aerodynamics, construction, riggings and Lewis gun instruction. In the class rooms is a Curtiss J. N. 4 flying machine and several engines, besides a Lewis gun, so that the instructors are able to combine theory and practice.

The fuel administrator has granted exemption to the school so that it will be able to keep open on Mondays. Besides morning and afternoon classes there is also a night class.

Sprague Electric Works Changes

Frank W. Hall has been appointed Commercial Manager of the Sprague Electric Works of General Electric Co. With the exception of a short period, Mr. Hall has been connected with the Sprague Works continuously for twenty-two years in various engineering and sales capacities, and for the three years prior to his present appointment occupied the position of sales manager. D. C. Durland, former executive head of the Sprague Electric Works, has resigned to accept the Presidency of the Mitchell Motors Co., Inc.

L. E. Joels Is Duesenberg Works Manager

The Duesenberg Motors Corporation announce that on Jan. 1, L. E. Joels became works manager for their Elizabeth, N. J., factory, vice Charles B. Page, resigned. Mr. Joels has had a very wide experience in factory production and factory management, serving until recently as works manager of the Packard Motor Car Co.

Whitman & Barnes Calendar

The Whitman & Barnes Mfg. Co., manufacturers of "Hercules" drills, whose general offices are at Akron, Ohio, with salesroom at 64 Reade Street, New York, has issued a very attractive calendar for the new year.

Du Pont Buys Bridgeport Co.

The paint and wood finishing business of the Bridgeport Wood Finishing Co. of Still River, Conn., has been purchased by E. I. du Pont de Nemours & Co.

Tests Thomas-Morse Airplanes

During January extensive field tests of the airplanes manufactured by the Thomas-Morse Aircraft Corp., Ithaca, N. Y., were made at Lake Charles, La. Flights were made every day by Frank Burnside, who reports that the machines met every test and showed both great speed and power.

Senate Confirms Aircraft Board Nominations

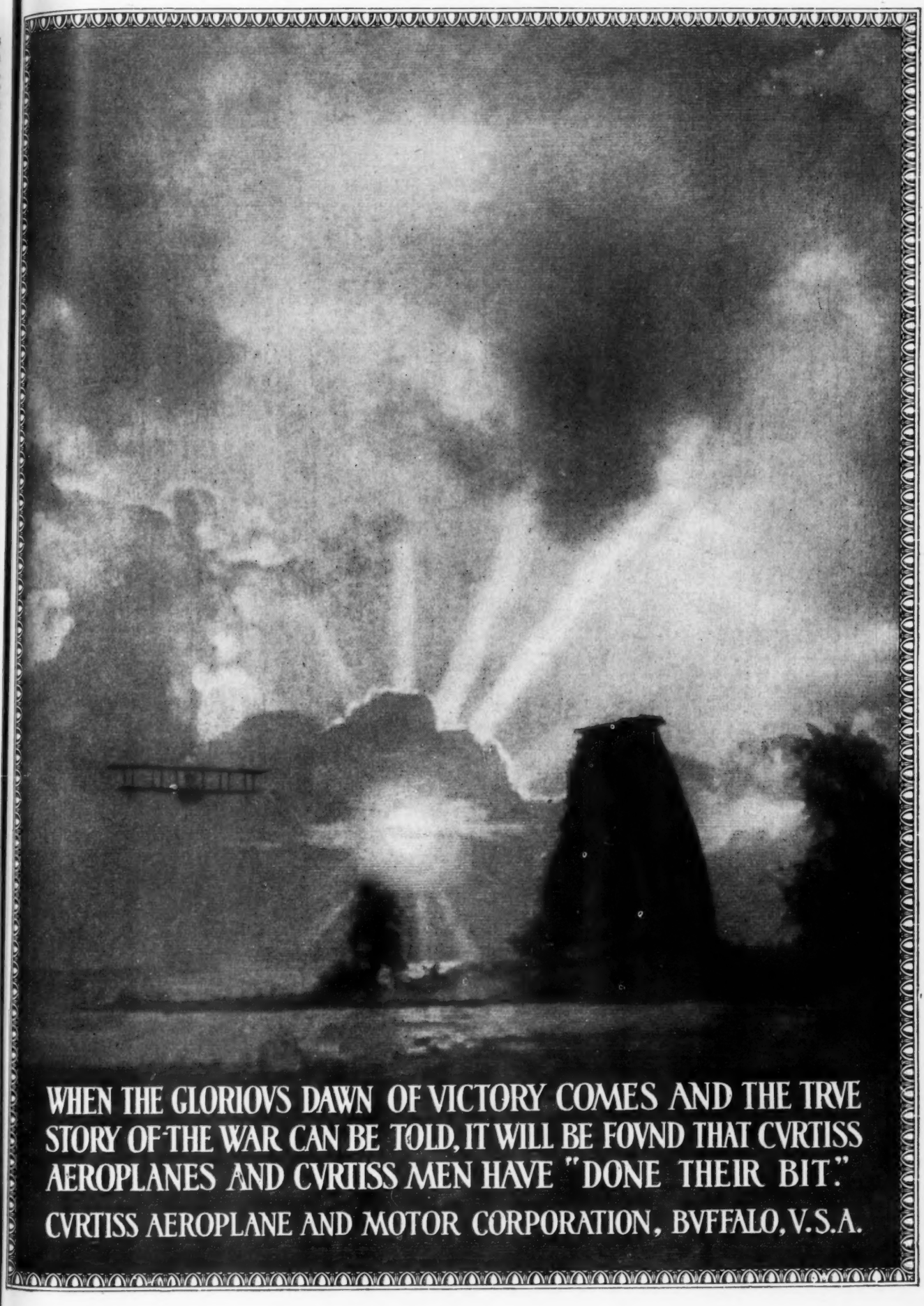
The executive nominations of Howard E. Coffin and Richard F. Howe as civilian members of the Aircraft Board were confirmed by the Senate on Feb. 14. One other civilian appointment still remains to be made to complete the nine members of the Board.

Flight Tests of Avro Biplanes

Successful exhibition tests of the Avro training two place biplane were made in Washington, D. C., last week. The flights were made by Lieut. Col. C. F. Lee, Chief of the British Aeronautical Mission, and Lieut. John A. Sully, a member of the Canadian Branch of the Royal Flying Corps.

Urgent Deficiency Bill

In the urgency deficiency bill reported to the House of Representatives by the Committee on Appropriations on Feb. 14, $13,200,000, in addition to appropriations before made is appropriated for the Secretary of the Navy for anti-aircraft batteries and outfits. The total direct and contract appropriations are $1,107,220,082.46, of which $49,130,072.25 is for the naval establishment and $579,232,975 for the military establishment.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STORY OF THE WAR CAN BE TOLD, IT WILL BE FOVND THAT CVRTISS
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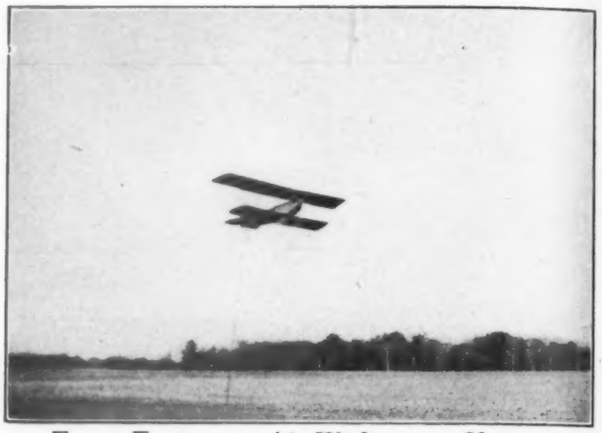

From Factory to Air Without a Change

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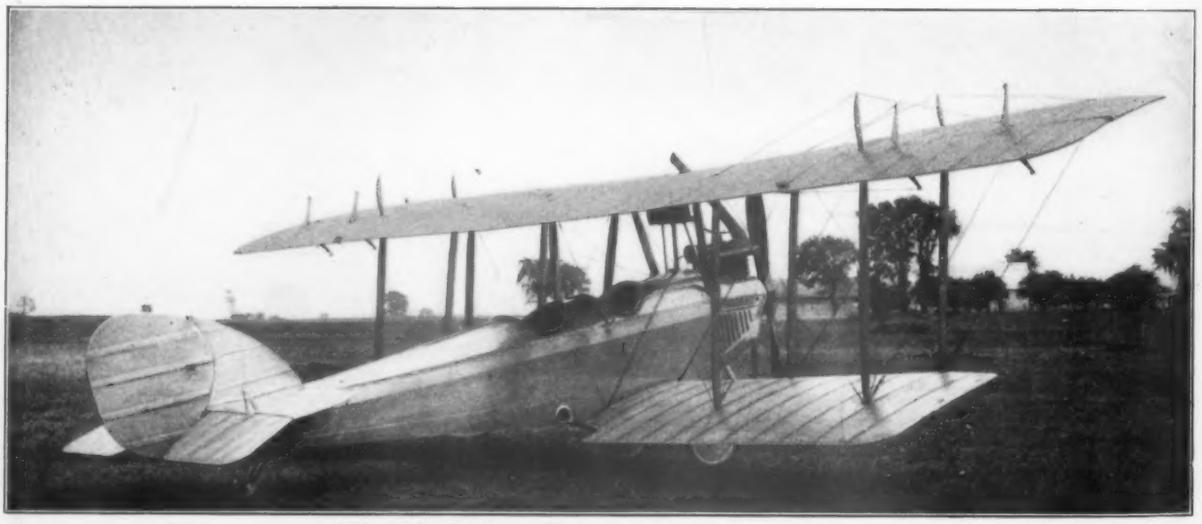

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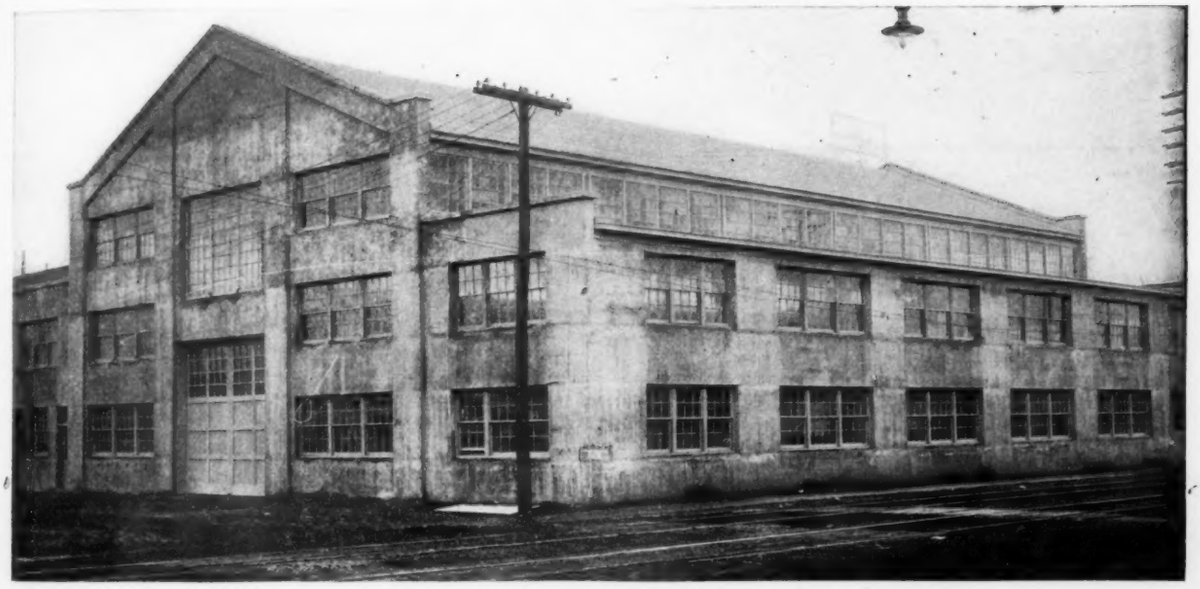
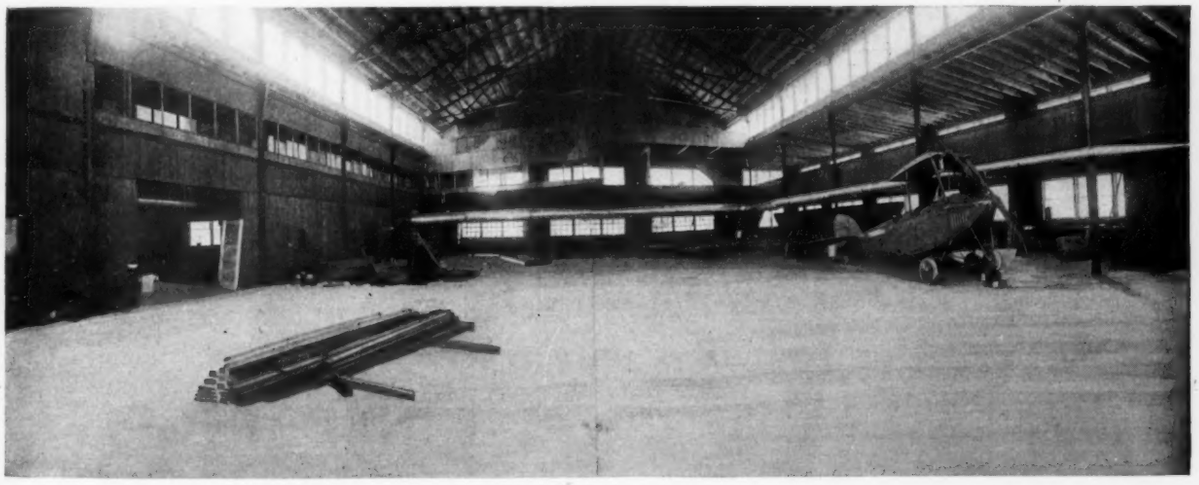


First Section of the Great New Airplane Plant Being Erected by the Lawson Aircraft Corporation at Green Bay, Wis.



Interior view of the first section of the new Lawson airplane plant. The plans were drawn with a view to making it the most modern, efficient and best equipped airplane plant in the world. On the upper left hand balcony are arranged the Manager's office and offices of the Chief Engineer, Consulting Engineer, Designing Engineer, Chief Inspector, Government Inspector, Production Manager, Assistant General-Manager, Assistant Chief-Engineer, Chief Draftsman and forty Draftsmen. This section, which was still in course of construction when this picture was taken, is now occupied and equipped with the latest airplane machinery and workmen busily engaged manufacturing the latest Lawson Airplanes.

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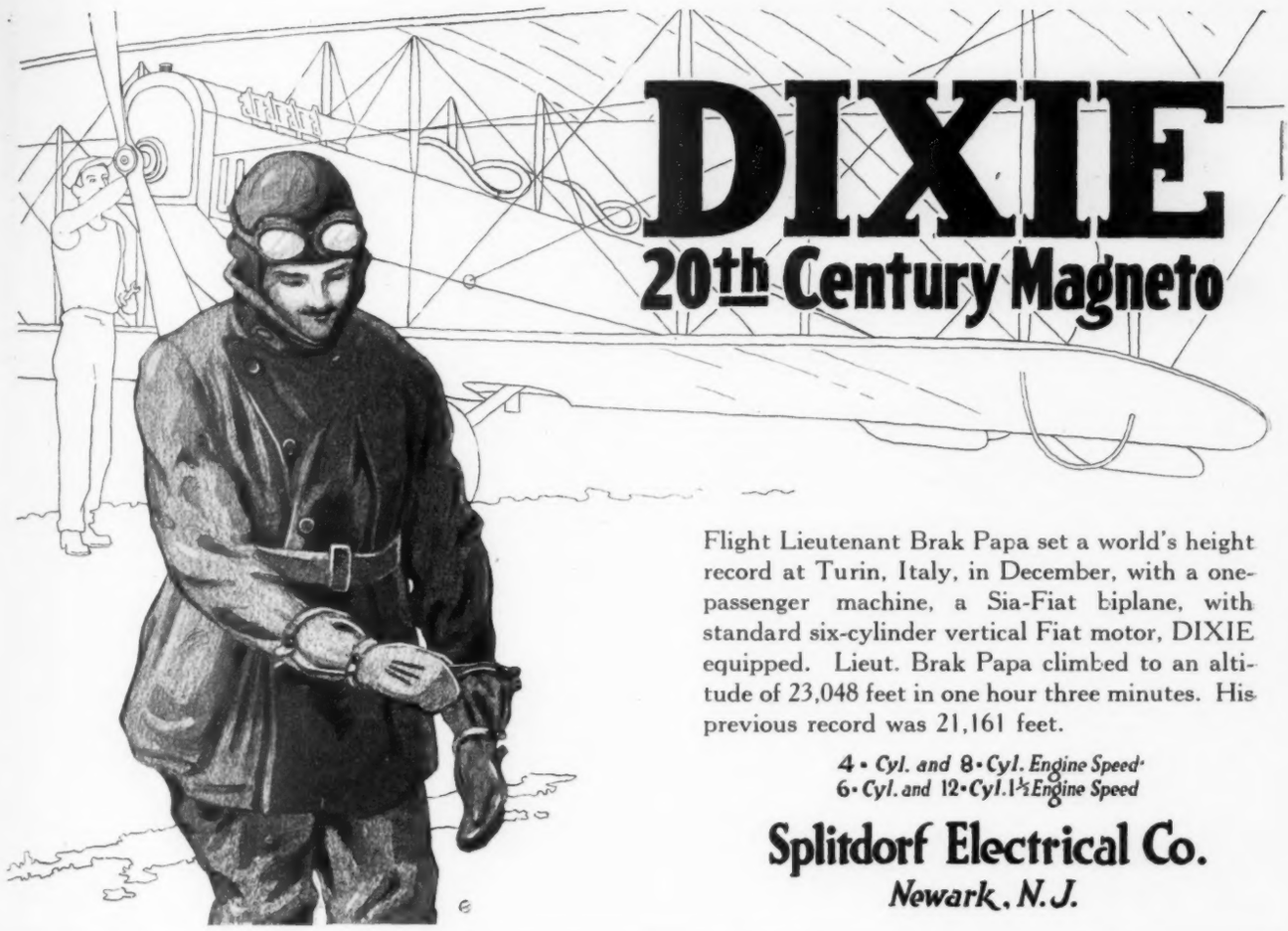

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Flight Lieutenant Brak Papa set a world's height record at Turin, Italy, in December, with a one-passenger machine, a Sia-Fiat biplane, with standard six-cylinder vertical Fiat motor, DIXIE equipped. Lieut. Brak Papa climbed to an altitude of 23,048 feet in one hour three minutes. His previous record was 21,161 feet.

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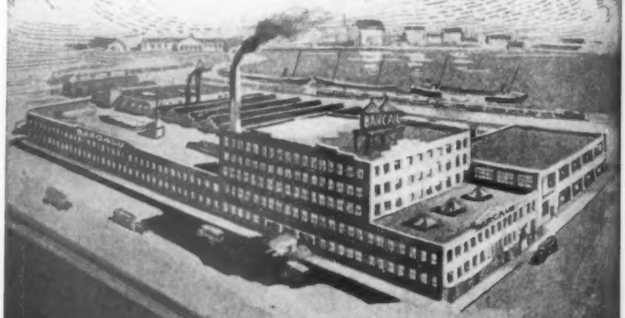

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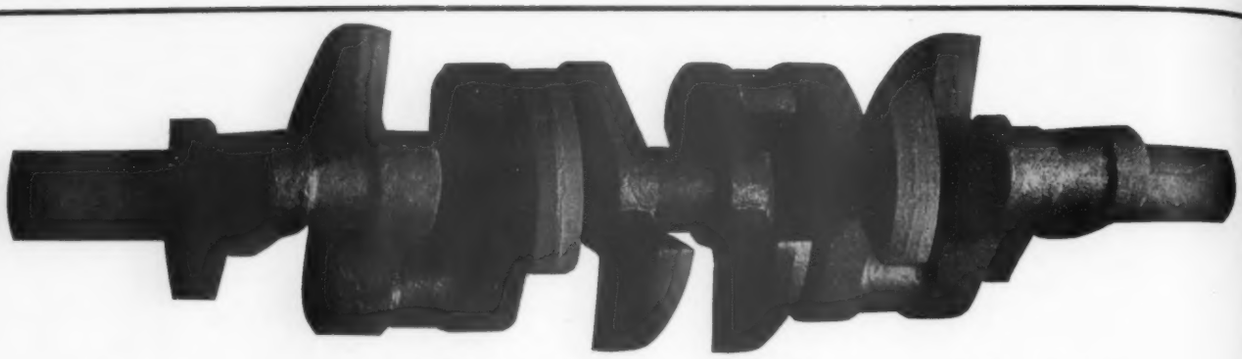

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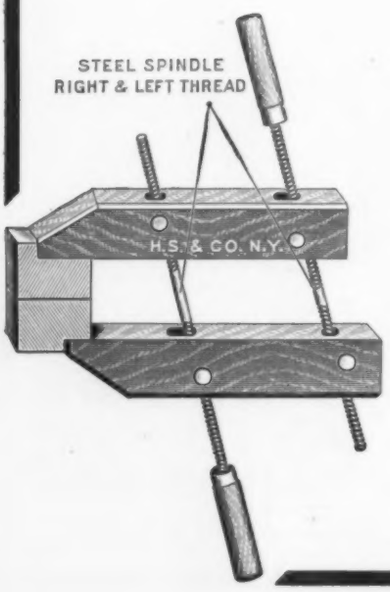

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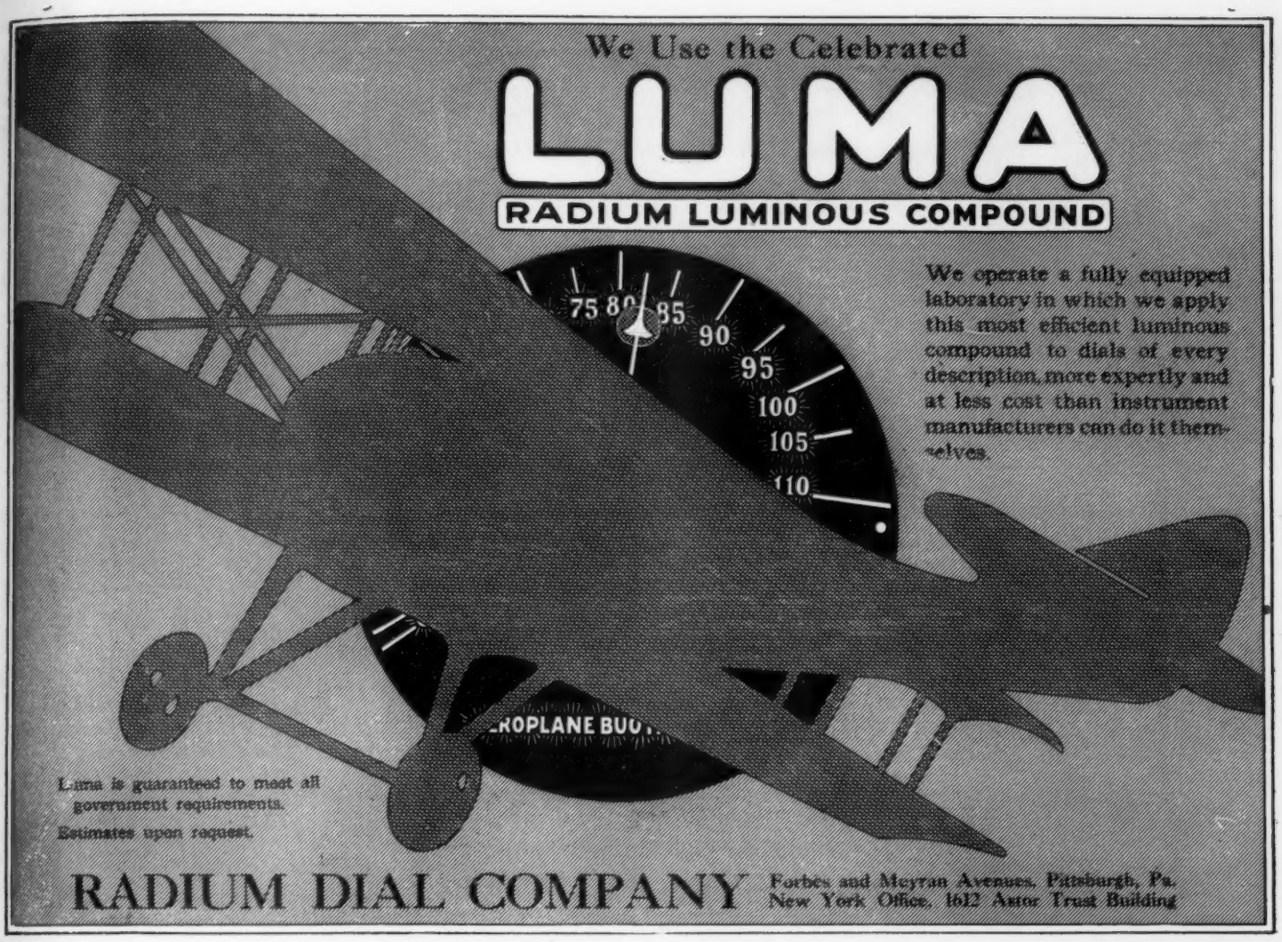
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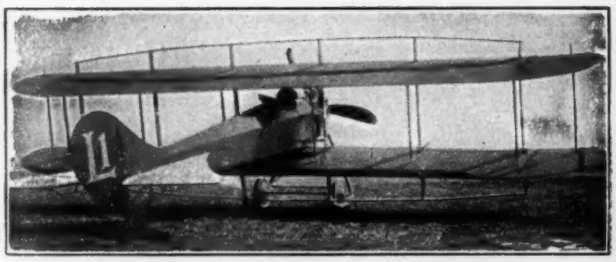

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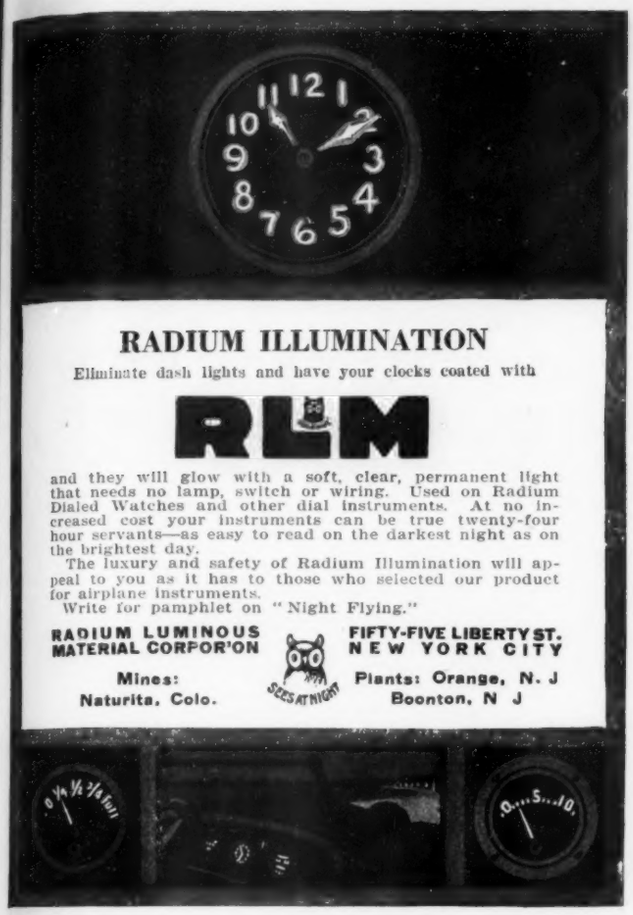

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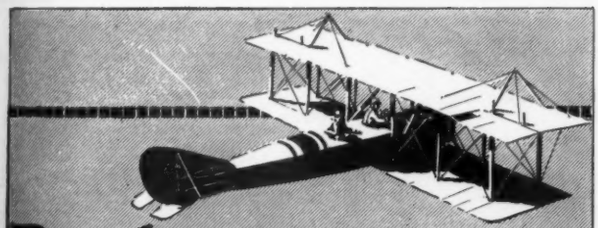

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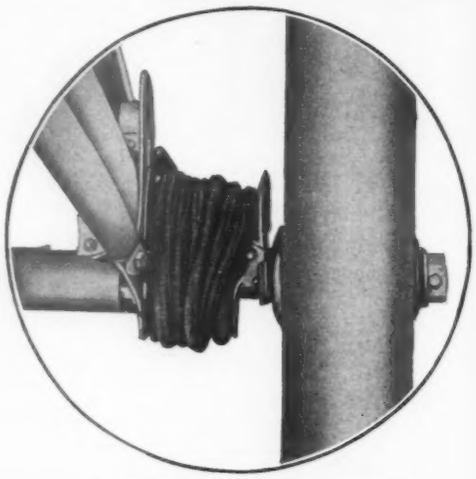

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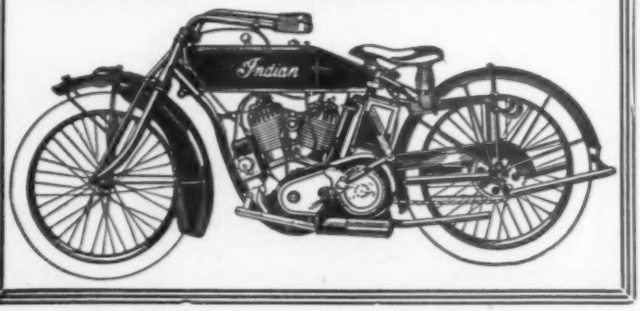

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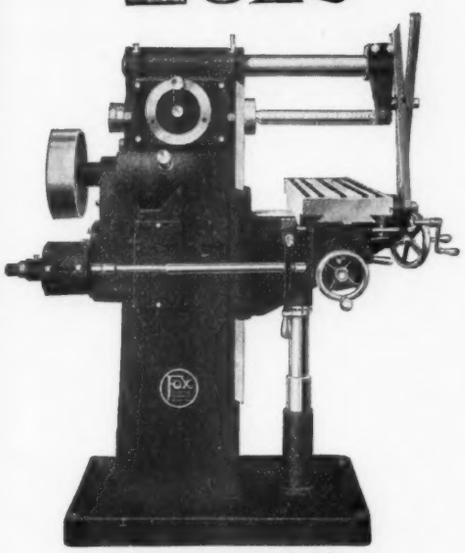

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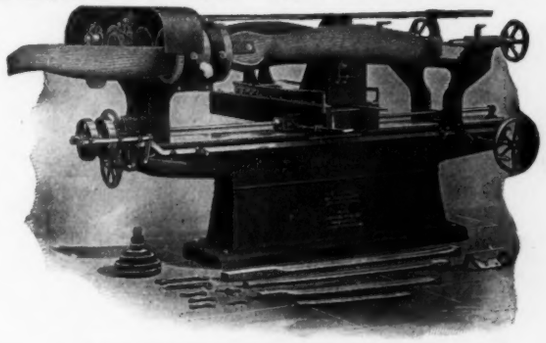

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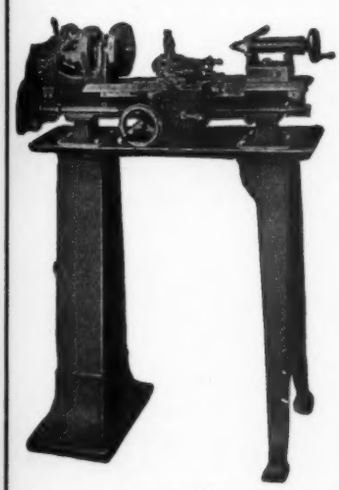

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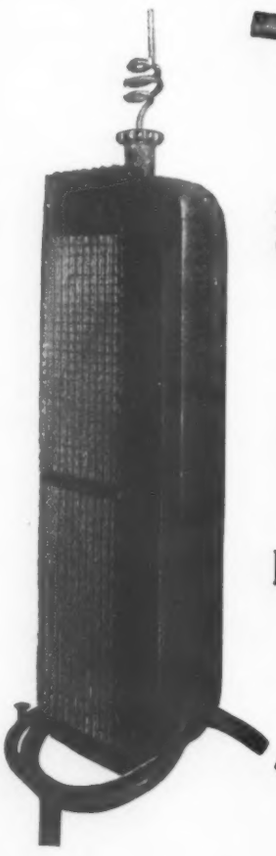

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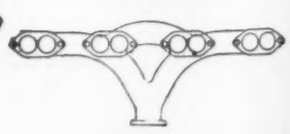

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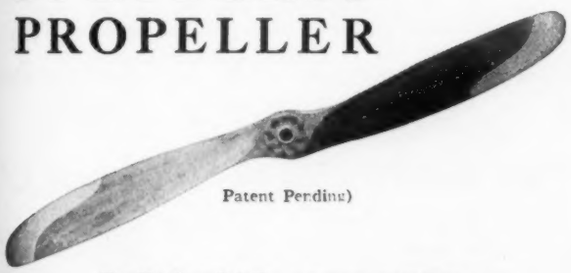

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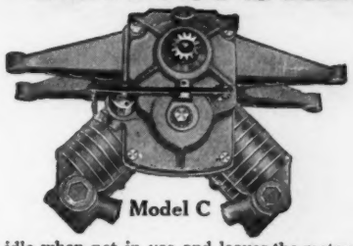

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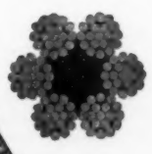

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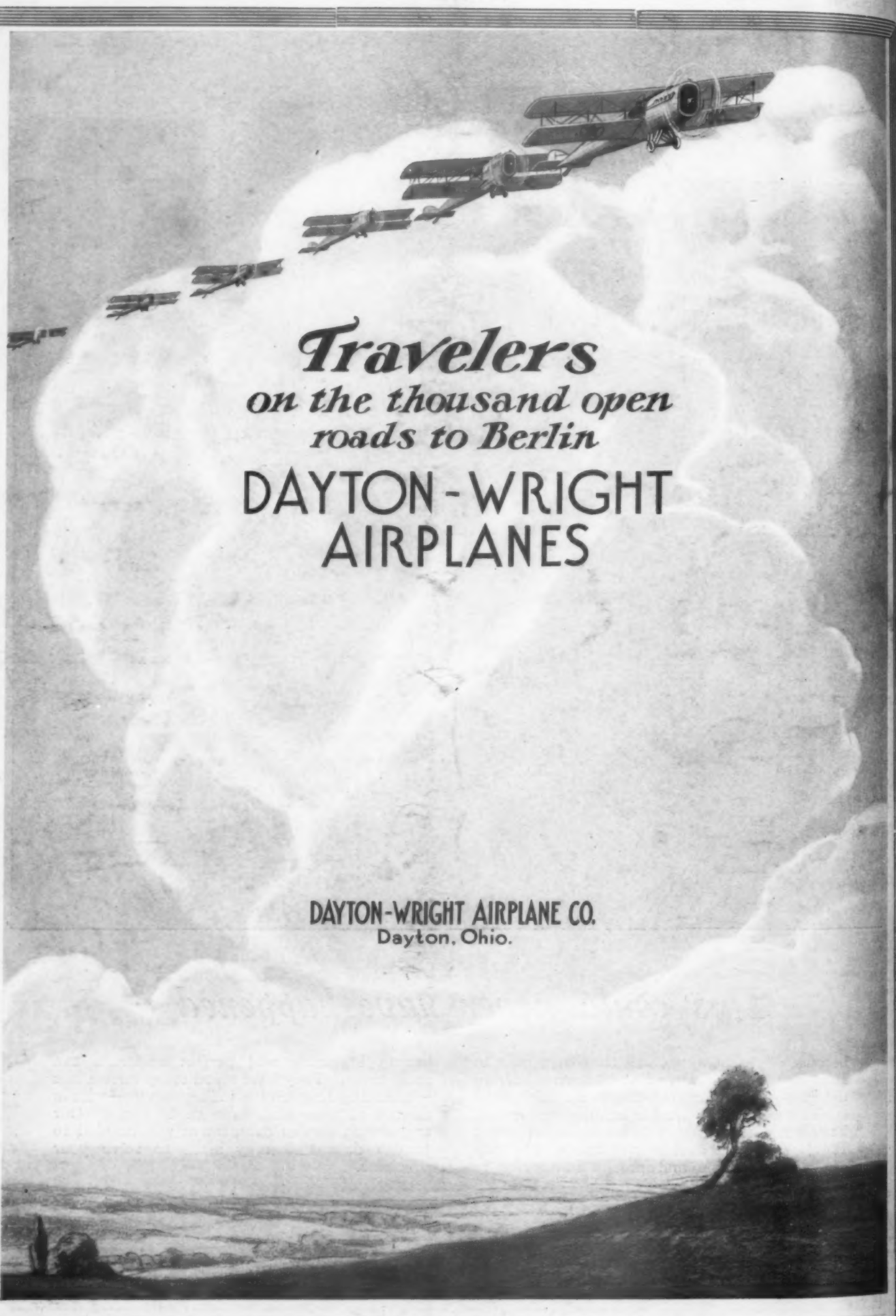
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